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The Vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: A Habitat Type Classification

Paul L. Hansen and George R. Hoffman

Abstract

A vegetation classification was developed, using the methods and concepts of Daubenmire, on the Ashland, Sioux, and Grand River/Cedar River Districts of the Custer National Forest. Of the 26 habitat types delimited and described, eight were steppe, nine shrub-steppe, four woodland, and five forest. Two community types also were described. A key to the habitat types and some of the changes resulting from disturbances of the vegetation also are included.

Cover Photo.—Scattered *Pinus ponderosa* stands, Ashland District, Custer National Forest.

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The Vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: A Habitat Type Classification[1]

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Introduction

The vegetation of the northern Great Plains occupies an area of complex physiographic features, and the diverse plant communities include steppe, shrub-steppe, woodlands, and forests. Land managers and scientists alike have long recognized the need to classify plant communities and land units, and they have developed numerous forest and range type classifications over the years. Many such classifications have emphasized current plant communities (cover types) regardless of their successional status, or they have focused on a single-purpose objective, such as the management of land for producing livestock forage (range sites). Such classifications either have ignored potential climax vegetation or have evolved in such a way as to show either a perceived or a real lack of relationship to potential climax vegetation (Daubenmire 1984, Hoffman 1984, Pfister 1986). Pfister (1986) indicated the original concept of using potential climax vegetation as the foundation is very similar between the habitat type and range site classifications. However, the operational procedures for range site identification have evolved much closer to a direct physical site factor approach than to one based on potential vegetation.

In 1952, Daubenmire described a habitat type classification for the forested areas of northern Idaho and eastern Washington. Later Daubenmire and Daubenmire (1968) refined this classification of forest lands and published detailed data on the vegetational composition of each stand. In 1970, Daubenmire classified similarly lands supporting steppe vegetation in Washington. Accepting and adapting the habitat type system of classification for nonforested lands has been slower than for forested lands.

The present study was started in 1981 with the following objectives:

1. Develop a habitat type classification for lands supporting steppe, shrub-steppe, woodland, and forest vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest.
2. Relate the habitat types to soils and climatic data as closely as possible.
3. Relate Custer National Forest habitat types to those of similar studies in this and adjacent regions.

This habitat type classification, completed in 1985, is based on concepts and methods developed by Daubenmire and Daubenmire (1968), Daubenmire (1970), Hoffman and Alexander (1976, 1980, 1983, 1987), and Hansen et al. (1984).

Previous Habitat Type Studies

While many earlier vegetation studies in the northern Great Plains region emphasized management or carried an autecologic emphasis, a few recent studies have employed the habitat type concept in classifying land units. Hansen et al. (1984) described and classified 10 habitat types involving steppe, shrub-steppe, and woodland vegetation of Theodore Roosevelt National Park, North Dakota. Seven of these habitat types also occur in the present study area. In a study along the Missouri River breaks of north-central Montana, Mackie (1970) described 12 habitat types, four of which were recognized in this study. Hoffman and Alexander (1976) identified 14 forest habitat types in the Bighorn Mountains of north-central Wyoming, three of which also occur in the present study area. In their study of forest habitat types of Montana, Pfister et al. (1977) sampled only a few stands in southeastern Montana; however, three of their habitat types dominated by *Pinus ponderosa* also were present in this study. In a study of the forest habitat types of the Crow and Northern Cheyenne Indian Reservations in eastern Montana, Cooper and Pfister (1984) identified 25 habitat types, three of which were recognized in this study. In the steppe and shrub-steppe areas of western Montana, Mueggler and Stewart (1980) identified 29 habitat types, four of which were identified in this study. Of the 19 habitat types Jorgenson (1979) described for the Yellow Water Triangle of Montana, at least four occur in the area covered by this study. In a recently completed study, Hoffman and Alexander (1987) identified seven *P. ponderosa*-dominated habitat types and one *P. ponderosa*-dominated community type in the Black Hills. Two of these habitat types also occur in this study, and the community type was identified as a habitat type in the present study.

Study Area

Physiography and Geology

The Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest (fig. 1) lie within the unglaciated Missouri Plateau section of the Great Plains Province (Fenneman 1931, Montagne et al. 1982). The Missouri Plateau is characterized as an upland plain interrupted by tablelands, drainageways, streams, and rivers. The dominant feature of the region is the rolling, terrace-like, steppe-dominated plains consisting of soft-

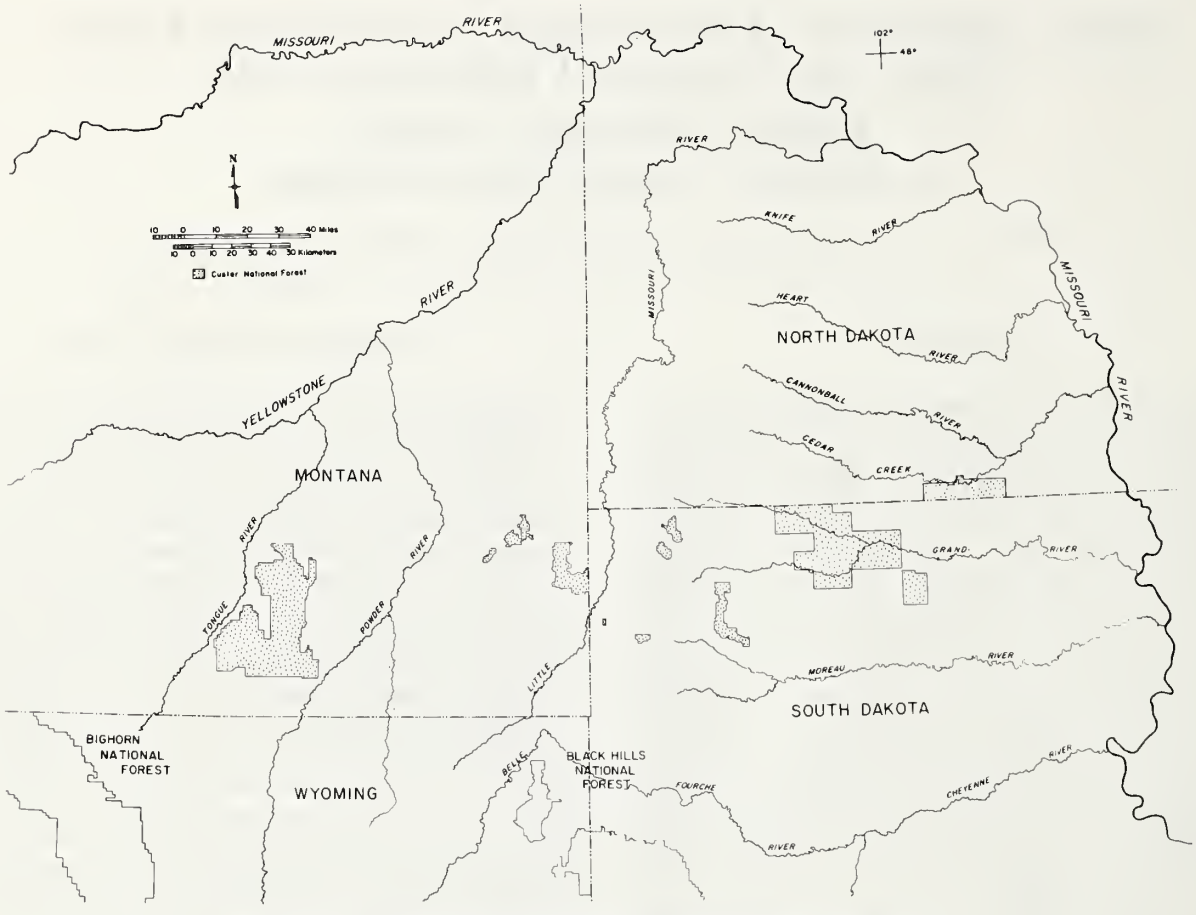

Figure 1.—Custer National Forest showing locations of the Grand River/Cedar River, Sioux and Ashland Districts.

ly consolidated and cross-bedded silt, clay, sand, and hard porcelainite shale of the Cretaceous and Tertiary Periods. Also present are alluvial deposits laid down during the Quarternary Period. Along drainageways, the deposits form smooth, coalescing alluvial fans, foot slopes, and stream terraces varying in width from 1,312 feet (400 m) to 3.1 miles (5 km). Most tablelands of the area are capped with resistant sandstone and form prominent features of the landscape.

The Grand River Ranger District administers the Grand River National Grassland in Perkins and Corson Counties of South Dakota, and the Cedar River National Grassland in Sioux and Grant Counties of North Dakota. The landscape of the Grand River District is an upland plain moderately dissected by streams and entrenched drainageways. Relief is gently rolling to steep in much of the region, with a few prominent buttes and ridges (fig. 2). The main drainages are the Grand River and Cedar Creek, which flow easterly to the Missouri River.

The Sioux District is located in Carter County of southeastern Montana and Harding County of northwestern South Dakota. Characteristic of the region are eight land units that rise 328 to 984 feet (100 to 300 m) above the surrounding plain. These are the North Cave Hills, South Cave Hills, Slim Buttes, East Short Pines, and West Short Pines in South Dakota, and the Long Pikes, Ekalaka Hills, and Chalk Buttes in Montana (fig. 3). All are sandstone buttes and hills that are geologic remnants of the Fort Union Formation and the Hell Creek Formation of the Tertiary Period overlying the Cretaceous tablelands of eastern Montana and western South Dakota (Montagne et al. 1982, Stone et al. 1983). The main drainages are the Grand and Moreau Rivers that flow eastward and the Little Missouri River that flows northward to the Missouri River.

The Ashland District lies between the Tongue River and the Powder River in Rosebud and Powder River Counties of southeastern Montana. The surface geology of the region is comprised of the Tongue River Member of the Fort Union Formation. It consists of nearly level bedded, weakly consolidated soft sandstones, silty sandstones, clayey shales, and lignite beds (Warren 1959). Large areas of the lignite beds have burned, and heat from the burning lignite has baked and oxidized adjacent shale beds to produce brittle, reddish-colored iron-oxide porcelainite, locally called scoria and clinker beds.

The soft shales and sandstones of the Fort Union Formation erode readily and have formed intricately dissected plateau topography with a complex of high and intermediate bench levels. Common landscape features include badlands, sandstones, shale escarpments, and scoria buttes with highly irregular topography. South-facing slopes generally have more exposure of shale and sandstones and a larger number of drainages. The scoria

or porcelainite beds form a distinct topography with isolated irregular buttes and some slump-like relief with an underdeveloped drainage. Stream valleys have a complex pattern of bottom lands, low terraces, and local alluvial fans. The main drainages are the Tongue River and the Powder River, which flow northward to the Yellowstone River.

Climate

The relatively xeric continental climate of the region is characterized by long, cold winters and short, warm summers. The January mean is 17.4° F (–8.1° C), and the July mean is 71.6° F (22° C). In a normal year, about 75% of the annual precipitation falls during the growing season from April through September; approximately 50% falls during April, May, and June (fig. 4). The mean annual precipitation ranges from approximately 13 inches (330 mm) at Ashland, Mont., to 16.5 inches (420 mm) at Bison, S. Dak. Topography of the Ashland District influences the precipitation pattern. Annual precipitation varies from about 20 inches (508 mm) in the south-central part to 13 inches (330 mm) along the south, east, and west boundaries of the district and 15 inches (381 mm) along the northern boundary. Similar variations in precipitation also occur in the Sioux District (U.S. Department of Commerce 1965a, 1965b).

Figure 2.—Characteristic steppe-dominated landscape of the Grand River/Cedar River District, Custer National Forest.

Figure 3.—Characteristic landscape of the Sioux District, Custer National Forest.

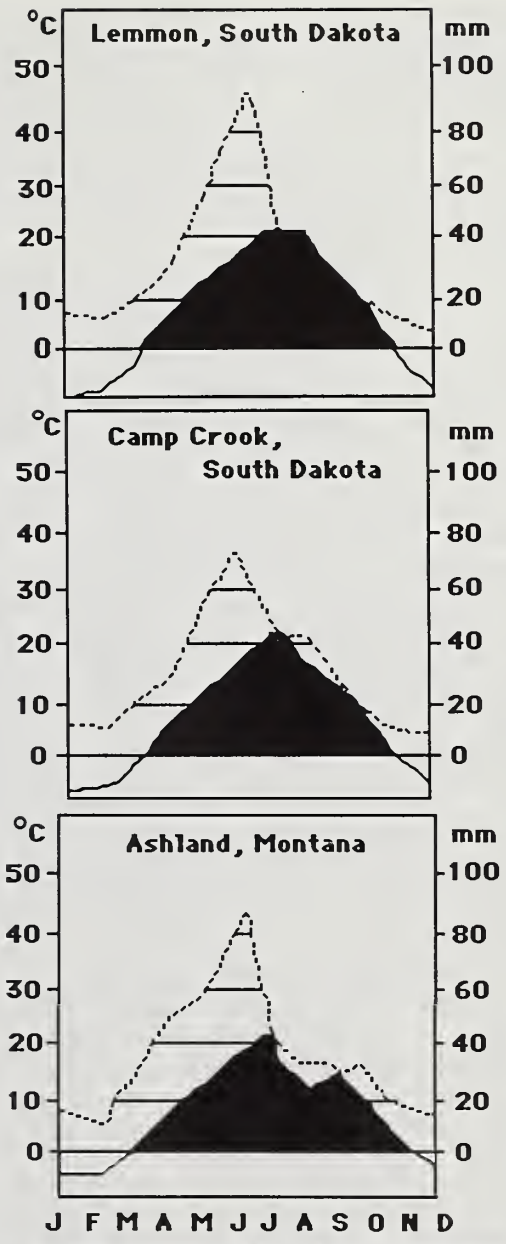

Figure 4.—Average monthly temperature and precipitation at three locations in or near the Custer National Forest, Montana and South Dakota. Temperature (°C) is indicated by the broken line, precipitation (mm) by the solid black area.

Ecological Terms and Concepts

Concepts and terminology in this report are consistent with usage proposed by Daubenmire (1968a, 1978) and used in numerous studies of habitat types.[3]

[3]*These include: Alexander 1985; Alexander et al. 1984a, 1984b; Alexander et al. 1986; Cooper and Pfister 1984; Daubenmire 1970; Daubenmire and Daubenmire 1968; DeVelice et al. 1986; Hanks et al. 1983; Hansen et al. 1984; Hironaka et al. 1983; Hoffman and Alexander 1976, 1980, 1983, 1987; Mauk and Henderson 1984; Moir and Ludwig 1979; Mueggler and Stewart 1980; Pfister et al. 1977; Pfister and Arno 1980; Steele et al. 1981, 1983; Youngblood and Mauk 1985.*

"Climax vegetation" is that which has attained a steady state with its environment, and in the absence of excessive disturbance, species of climax vegetation appear to maintain their population sizes. "Seral vegetation" is that which has not theoretically attained a steady state, and current populations of some species are being replaced by other species. "Habitat type" is that land area that supports, or has the potential of supporting, the same primary climax vegetation.

The following classification of climax vegetation was first proposed by Tansley (1935) and later modified by Daubenmire (1952). "Primary climaxes" develop on habitats where recurring disturbance is not a factor influencing the structure or composition of the vegetation. "Climatic climax" vegetation develops on normal topography with fairly deep, well-drained, loamy soil. Where topography or soil exert sufficient influence to produce a self-perpetuating, steady-state vegetation distinct from the climatic climax, the term "topographic climax" or "edaphic climax," respectively, is used. Where special topographic conditions also favor the development of edaphic conditions distinct from the normal and the climax vegetation is distinct from the climatic climax, the term "topoedaphic climax" is used. Where recurring disturbances, such as grazing or fire, exert the predominant influence in maintaining the structure and composition of the steady-state vegetation, the term "disclimax" is used. A "zootic climax" is stable vegetation that is distinct as a result of heavy recurring use by animals. "Fire climax" is stable vegetation that is distinctive as a result of periodic burning. Disclimaxes—the zootic climax or fire climax—are not the basis for recognizing habitat types.

"Plant association" is a term used to group together all those stands of climax vegetation that occur in environments so similar that there is much floristic similarity throughout all layers of the vegetation. For example, numerous stands of the *Stipa comata/Carex filifolia* plant association occur. The units of land on which these occur represent the *S. comata/C. filifolia* habitat type. This latter nomenclature is useful, because throughout the study region, most parcels of land support vegetation in a successional (seral) stage. Where those land units are recognized to be part of the *S. comata/C. filifolia* habitat type, they are so categorized. Thus, a multitude of variation in the matrix of vegetation over the landscape theoretically can be categorized into a manageable number of units. The categories are defined to represent, as closely as possible, the natural biotic potential (climaxes) of the region. "Community type" is a plant community of unknown successional status. In most cases, community types are seral and often long-lived. Thickets of *Symphoricarpos occidentalis*-dominated vegetation are interspersed through the vegetation matrix of several habitat types of Theodore Roosevelt National Park (Hansen et al. 1984). Because these stands probably are seral, though long-lived, they were considered a community type. The structure of vegetation can be thought of in terms of "unions," single species of high abundance and distinctive ecology or a rather well-defined group of species that occur together in approximately the same narrow range of environmental variation in the landscape. Unions may be distinct physiognomically. "Synusiae" or "layers" have closely similar definitions in the ecologic literature.

As it is theoretically the end result of succession, the climax plant community is an expression of the biotic potential of the site where it occurs. Each habitat type is a relatively narrow segment of environmental variation and is defined by a certain potential for vegetational development. Although one habitat type may support a variety of disturbance-induced or seral plant communities, the potential product of vegetational succession anywhere within one habitat type is theoretically the same climax community.

If succession can be recognized and understood, the long-term product of succession is the climax or steady-state community. Insofar as this community is self-perpetuating and its distinctiveness is time independent, it represents a meaningful integration of its total environment. It is on this basis that the climax vegetation is useful in the nomenclature of habitat types.

The habitat type classification provides a permanent and ecologically based system of land stratification in terms of vegetational potential (Daubenmire 1976). As the habitat type is the basic unit in classifying land units or sites based on their biotic potential, it emphasizes similarities and differences in ecosystems that carry implications for a variety of land management objectives (Daubenmire 1984). Some of the practical implications of habitat type classification are in predicting range and wildlife forage production and wildlife habitat values, timber production, species selection for regeneration methods, growth rates of ponderosa pine (Rioux 1984), susceptibility of trees to insects and disease, depth of soil moisture penetration, potential for producing browse after fire, impacts of recreational uses on the plant communities, natural areas for preservation, downed woody fuels on the forest floor, and successional trends after disturbance (Arno et al. 1985; Arno and Pfister 1977; Daubenmire 1961, 1968b, 1972; Fischer 1981; Fischer and Clayton 1983; Hansen et al. 1985; Hoffman 1984; Layser 1974; Mueggler and Stewart 1980; Pfister 1986). Habitat types offer a basis of comparison and evaluation in designing and carrying out field experiments in ecology or applied natural resource disciplines.

Methods

This study was started in 1981 with a reconnaissance survey. All the roads and trails and many off-road areas were traveled, and attention was spread rather uniformly over the entire study region, searching for sites that showed least amounts of disturbance. In all, about 200 sites were evaluated on a reconnaissance basis. Some of the sites were visited during each growing season of the study to verify the effects of significant differences in precipitation from one year to the next.

At each site, the plants observed were listed and coverage of the more important species estimated. The topographic position of the site, its elevation, slope and

aspect, and the approximate texture of the surface soil also were noted. Any prominent geologic and/or physiographic features at each site also were recorded. Though the sites were selected subjectively, the choices were based on a recognition of dominant plants and the presence of various species to indicate grazing or no grazing influence. Knowledge of the vegetation within and near Theodore Roosevelt National Park plus reference to studies of others in nearby areas were useful in selecting sites. In all cases, vegetation considered to exhibit the least amount of disturbance, and climax or near-climax,was sought. Based on the reconnaissance data, stands were tentatively grouped into habitat types.

During the field seasons of 1982, 1983, and 1984, 169 stands were intensively sampled. Some were taken from the list of reconnaissance sites; others were located during the time of intensive sampling. The number of plots sampled to describe each habitat type was based on the variability in coverage, frequency, and composition of vegetation. Habitat types with the greatest variability were sampled more often than those with less variability.

Somewhat different sampling techniques were used for forest and steppe or shrub-steppe vegetation. For forest vegetation, a rectangular plot 49.2 x 82.0 feet (15 x 25 m) was laid out with the long axis parallel to the contour of a slope to maximize the chance of remaining within the same soil type. The sample plots included the largest trees of the stand, provided the trees were not located near trails, ecotones, or other disturbances. Thus, the undergrowth vegetation and soil were most representative of the oldest part of the stand. Within each 4,036-square foot (375-m^2) main plot, all trees taller than 3.28 feet (1 m) were measured at breast height and recorded by 3.28-foot (1-dm) diameter classes. All trees less than 3.28 feet (1 m) tall throughout the plot also were tallied. In calculating tree basal areas, the midpoints of the diameter classes were tallied. Because the largest trees were included in the plots, the basal areas calculated were higher than would be expected for the average stand. The technique was used consistently, however, throughout the study, so the results were comparable from one stand to another. In determining basal area of *Juniperus scopulorum*, only the main stems were measured.

Each main plot was subdivided into three 16.4- x 82.0-foot (5- x 25-m) subplots. Canopy coverages for each shrub, forb, and graminoid undergrowth species were estimated within fifty 7.9- x 19.7-inch (2- x 5-dm) microplots placed at 3.28-foot (1-m) intervals along the inner sides of the central subplot. Canopy coverage for each species was recorded in one of six coverage classes: 1 = 0–5%, 2 = 6–25%, 3 = 26–50%, 4 = 51–75%, 5 = 76–95%, 6 = 96–100% (Daubenmire 1959). Mosses and lichens were combined for coverage estimates. Plant species in the main plot that did not occur in any of the fifty microplots also were noted. Increment cores of at least two of the largest trees present were sampled in each plot to provide estimates of the age of the stand.

Stands of steppe or shrub-steppe vegetation were sampled along a 164-foot (50-m) line transect that followed the contour of the hill (Daubenmire 1970). The sampling transect was placed within the least disturbed and most mature part of each stand. Here the fifty microplots were placed on alternate sides of the line. To calculate coverage and frequency values, methodology described by Daubenmire (1959) was used.

Finally, 25 soil cores representing the upper decimeter of the mineral soil were collected from each stand. These samples were composited and air-dried in the field.

In the laboratory, the dried soil samples were first passed through a 0.01-inch (2-mm) sieve. A modified Bouyoucos method (Moodie and Koehler 1975) was used to determine soil texture, and Hach Chemical procedures to determine pH (using a plastic-body electrode on the saturated soil paste), exchangeable Ca and Mg (EDTA titration method), K and P (bicarbonate method of extraction, a modification of the Olsen method), pH lime requirement (Ohio SMP method), cation exchange capacity and base saturation (addition method), and organic matter content (dichromate method).

Vegetation data were listed in association tables that grouped the stands within relatively distinct habitat types. Species among all layers of the vegetation were considered in grouping of stands, with first consideration given to climax dominants. For example, stands dominated by *Artemisia tridentata* were not grouped with those dominated by *A. cana*, since each shrub occupies relatively distinct habitats in the study area. The undergrowth in these cases may be quite similar, but the split is made on the basis of the single dominant and abiotic considerations. In the case of *Artemisia tridentata/Agropyron spicatum* and *Artemisia tridentata/Agropyron smithii* habitat types, the separation was made on the basis of undergrowth vegetation and on abiotic factors. The procedure is used throughout in grouping and regrouping stands, and developing, on the basis of both vegetation data and abiotic factors, a list of habitat types for the study region. Results of this study are first approximations in the sense that all vegetation data can be split more finely and result in more habitat types. However, based on data and knowledge of the region, it appears that the habitat types delimited and described will cover at least 85% of the landscape bearing vegetation in the study region (Daubenmire 1952, 1970; Daubenmire and Daubenmire 1968; Mueller-Dombois and Ellenberg 1974).

The following information is documented in the appendix tables: (1) tree population data (table A–1, appendix 1); (2) coverage and frequency data, location and number of stands sampled for each habitat type and community type (tables A–2 through A–25, appendix 2); and (3) soil analysis data for each habitat type and community type (table A–26, appendix 3).

Nomenclature for plants sampled in this study follows Van Bruggen (1976) and Barkley (1977). Although plants were collected at various times during the growing season and attempts were made to identify all specimens to species, there still were some difficulties related to the lack of clear taxonomic differences among certain species. Voucher specimens collected in the study were deposited in the herbarium at the University of South Dakota.

Steppe Habitat Types

Stipa comata/Carex filifolia

This habitat type, which occurs on nearly level plateaus, isolated buttes, and gentle slopes that appear to be relatively free from excessive erosion (fig. 5), is restricted to the eastern and central portion of the study region. In the 18 stands sampled, 90 species were recorded (table A–2). *Stipa comata*, *Carex filifolia*, *Agropyron smithii*, *Bouteloua gracilis*, *Artemisia frigida*, and *Koeleria pyramidata* provide the greatest coverage. Three unions usually are present in this association. *S. comata* forms the dominant union. Beneath the *S. comata* union is the *Agropyron smithii* union, which includes *K. pyramidata*, *Artemisia dracunculus*, *A. ludoviciana*, and *Lygodesmia juncea*. The lowest growing union of this association is dominated by *C. filifolia*, with a mean coverage of 53.9%. Other important species of this union are *B. gracilis*, *A. frigida*, *Gaura coccinea*, *Carex eleocharis*, and *Sphaeralcea coccinea*.

In the 18 stands sampled, 17 species had constancies of 50% or higher. Constancy and mean coverage percentages of major species are as follows:

Species	Constancy (%)	Mean coverage (%)
Stipa comata	100	76.4
Carex filifolia	100	53.9
Bouteloua gracilis	100	6.7
Agropyron smithii	94	10.2
Artemisia frigida	94	5.0
Gaura coccinea	83	0.4
Sphaeralcea coccinea	83	0.9
Koeleria pyramidata	78	4.3
Carex eleocharis	78	2.5
Lygodesmia juncea	78	0.6
Artemisia dracunculus	67	1.7

Figure 5.—Well-developed stand of the *Stipa comata/Carex filifolia* habitat type in the Ashland District, southeastern Montana. The meter stick used for scale in this and subsequent figures is in decimeter segments.

Figure 6.—Seral stands of *Agropyron cristatum* in the Grand River District, Custer National Forest, that are successional to the *Stipa comata/Carex filifolia* habitat type.

Compared to other steppe habitat types, forbs are relatively important but graminoids provide the greatest coverage. The mean graminoid coverage for the *S. comata/C. filifolia* habitat type is exceeded only by that of the *Calamovilfa longifolia/Carex heliophila* habitat type (table 1).

Soil textures range from loams to loamy sands. The high sand content of soils of *S. comata*-dominated vegetation corresponds to findings of others (Coupland 1961, Daubenmire 1970, Dix 1960, Hansen et al. 1984, Hanson 1935, Hanson and Whitman 1938, Lauenroth and Whitman 1977, Wright and Wright 1948). Sandy soils in this climate have a high infiltration rate, deep penetration of water, high moisture availability, but low moisture-holding capacity (table A–26).

Hansen et al. (1984) described the *S. comata/C. filifolia* plant association in Theodore Roosevelt National Park of western North Dakota, where it is considered to be a climatic climax. Much of the region once was planted with *Agropyron cristatum*, but signs of succession to the *S. comata/C. filifolia* plant association are evident in numerous locations (fig. 6). Mueggler and Stewart (1980) described an *Agropyron smithii* phase of a *S. comata/Bouteloua gracilis* habitat type in southwestern Montana that appears to be similar to the *S. comata/C. filifolia* habitat type. Hanson and Whitman (1938) described a community in western North Dakota dominated by *B. gracilis*, *S. comata*, and *C. filifolia*, and they suggested this community closely reflected the macroclimate of the region. Coupland (1950, 1961) described a *S. comata/B. gracilis* community of western Canada where *C. filifolia* is important and *S. comata* is a "productive" species. Coupland reported *C. filifolia* increases in abundance south from Canada; with grazing, *B. gracilis* becomes a dominant species. Data from the present study tend to confirm this. Following disturbance, stands show an increase in *Artemisia frigida*, *A. dracunculus*, *A. ludoviciana*, and an invasion of *Bromus japonicus*. With increased disturbance, *B. gracilis*, *Festuca octoflora*, and *Artemisia cana* may increase dramatically. Following severe disturbance, *Opuntia polyacantha* and *O. fragilis* may dominate the community.

Table 1.—Sums of mean coverages (percent) of shrubs, graminoids, and forbs in the habitat types of the Custer National Forest.

Habitat type	Mean coverage		
	Shrubs	Graminoids	Forbs
Steppe			
Stipa comata/Carex filifolia	5.1	162.5	17.2
Stipa comata/Carex heliophila	2.2	140.9	28.7
Festuca idahoensis/Carex heliophila	1.3	115.6	10.0
Agropyron smithii/Carex filifolia	1.3	137.2	14.8
Andropogon scoparius/Carex filifolia	1.3	112.6	9.5
Calamovilfa longifolia/Carex heliophila	0.3	181.8	6.0
Agropyron spicatum/Bouteloua curtipendula	4.0	79.0	7.7
Agropyron spicatum/Carex filifolia	5.0	105.5	23.0
Shrub-Steppe			
Artemisia tridentata/Agropyron spicatum	24.8	60.8	4.4
Artemisia tridentata/Agropyron smithii	26.4	69.1	13.2
Artemisia cana/Agropyron smithii	35.2	120.9	5.2
Juniperus horizontalis/Carex heliophila	84.0	52.0	9.6
Rhus aromatica/Agropyron spicatum	31.9	57.4	4.5
Rhus aromatica/Festuca idahoensis	27.0	118.0	5.0
Rhus aromatica/Carex filifolia	30.5	93.5	4.3
Sarcobatus vermiculatus/Agropyron spicatum	38.5	17.7	0.3
Sarcobatus vermiculatus/Agropyron smithii	23.5	104.5	1.5
Woodland			
Juniperus scopulorum/Agropyron spicatum	2.5	35.3	5.3
Juniperus scopulorum/Oryzopsis micrantha	6.0	50.3	20.3
Fraxinus pennsylvanica/Prunus virginiana	78.9	74.6	33.4
Populus tremuloides/Berberis repens	65.3	63.8	15.3
Forest			
Pinus ponderosa/Agropyron spicatum	1.3	51.3	2.0
Pinus ponderosa/Festuca idahoensis	0.0	69.5	2.5
Pinus ponderosa/Carex heliophila	0.3	80.3	0.7
Pinus ponderosa/Juniperus communis	40.0	27.5	1.0
Pinus ponderosa/Prunus virginiana	88.4	43.8	11.2
Community types			
Symphoricarpos occidentalis	100.0	22.0	40.0
Shepherdia argentea	206.0	97.0	67.0

Stipa comata/Carex heliophila

This habitat type, which occupies upland plateaus or open parks surrounded by *Pinus ponderosa* (fig. 7), is widespread in the central and western portion of the study area. Along the eastern edge of its distribution, it occupies sites wetter than those of the *Stipa comata/Carex filifolia* habitat type. In the 10 stands sampled, 73 species were recorded (table A–3). *S. comata, C. heliophila, Artemisia ludoviciana, Agropyron smithii*, and *Koeleria pyramidata* provide the greatest coverage.

Figure 7.—*Stipa comata/Carex heliophila* habitat type surrounded by stands of *Pinus ponderosa*, Long Pines, Sioux District, Custer National Forest.

The *S. comata/C. filifolia* and *S. comata/C. heliophila* habitat types show similar physiognomies. The major differences in the vegetation are the presence of *C. heliophila* and considerably greater coverage of forbs in the latter. The *S. comata* union dominates both, and the *Agropyron smithii* union is well represented. The low-growing *C. heliophila* union has a mean coverage of 48.3%. Other members of this union are *Antennaria rosea, Aster ericoides, Rosa arkansana*, and *Petalostemon purpureus*. *Selaginella densa* grows in scattered, dense mats close to the soil surface. Its overall coverage is 16.3% and it is most abundant in the central portion of the study region. *S. densa* is rare outside this association.

In the 10 stands sampled, 24 species had constancies of 50% or higher. Constancy and mean coverage percentages of the major species are as follows:

Species	Constancy (%)	Mean coverage (%)
Stipa comata	100	61.5
Carex heliophila	100	48.3
Artemisia ludoviciana	100	6.1
Agropyron smithii	100	5.2
Koeleria pyramidata	100	5.1
Stipa viridula	90	5.4
Antennaria rosea	90	0.7
Gaura coccinea	90	0.2
Aster ericoides	80	1.7
Artemisia frigida	80	1.4
Rosa arkansana	70	0.6
Petalostemon purpureus	70	0.2

Owing to greater moisture in this habitat type, forbs provide almost twice the coverage as in the *S. comata/C. filifolia* plant association (table 1). Again, graminoids dominate this habitat type and provide the greatest coverage.

The *S. comata/C. heliophila* plant association is a climatic climax in the central and western portion of the study area. In typical stands, disturbance results in an increase in *Artemisia dracunculus, A. frigida, A. ludoviciana,* and an invasion of the alien species *Poa pratensis* and *Bromus japonicus.* With increased disturbance, *Artemisia cana,* and to a lesser degree *A. tridentata,* invade and eventually may dominate the community. These disturbed steppe sites can be distinguished from habitat types dominated by *A. cana* and *A. tridentata.* The *Artemisia cana/Agropyron smithii* habitat type occurs on alluvial deposits, and herbaceous species serve to distinguish the *Artemisia tridentata*-dominated habitat types.

Edaphic characteristics of the *S. comata/C. heliophila* and *S. comata/C. filifolia* habitat types are similar. Soil textures range from loams to loamy sands (table A–26).

There are few reports of *S. comata*-dominated communities having an abundance of *C. heliophila.* Hanson and Whitman (1938) described a community in western North Dakota dominated by *Bouteloua gracilis, S. comata,* and *C. filifolia* with limited amounts of *C. heliophila.* Larson and Whitman (1942) described a community dominated by *Agropyron smithii, S. comata,* and *Carex eleocharis* in the badlands of South Dakota where C. heliophila was more abundant on a protected mesa than on one periodically mowed and grazed. In Canada, Coupland (1961) described a *Stipa spartea* and *Agropyron dasystachyum* community in which *C. heliophila* was an important species. In western North Dakota, Redmann (1975) reported a *S. comata* community with an abundance of *C. heliophila.*

Festuca idahoensis/Carex heliophila

This habitat type, which occurs on upland plateaus or open parks that are surrounded by *Pinus ponderosa* (fig. 8), is restricted to the western portion of the study region. In the 8 stands sampled, 60 species were recorded (table A–4). The limited presence of *S. comata* and the constant occurrence and abundance of *Festuca idahoensis, C. heliophila, Koeleria pyramidata, A. ludoviciana, Aster ericoides,* and *Agropyron smithii* delineate this habitat type from other steppe habitat types.

Figure 8.—*Festuca idahoensis/Carex heliophila* habitat type on a gentle slope near Diamond Butte, Ashland District, southeastern Montana.

The physiognomy of the vegetation is similar to that of the *S. comata/C. heliophila* habitat type though the *F. idahoensis/C. heliophila*-dominated vegetation has less forb coverage, less leaf litter, and more exposed soil surface. The *F. idahoensis/C. heliophila* plant association also lacks the scattered dense mats of *Selaginella densa.* The *F. idahoensis* union is dominant, and its abundance and stature is indicative of this association. The *S. comata, Agropyron smithii, Artemisia frigida,* and *C. heliophila* unions also are represented. The *F. idahoensis/C. heliophila* plant association is climatic climax in the western portion of the study area.

In the 10 stands sampled, 22 species had constancies of 50% or higher. Constancy and mean coverage percentages of the major plants of this habitat type are as follows.

Species	Constancy (%)	Mean coverage (%)
Festuca idahoensis	100	75.3
Carex heliophila	100	25.5
Koeleria pyramidata	100	4.0
Artemisia ludoviciana	100	2.8
Aster ericoides	100	2.7
Agropyron smithii	100	2.6
Stipa comata	88	2.6
Rosa arkansana	75	0.8
Antennaria rosea	75	0.3
Artemisia frigida	75	0.3
Bouteloua gracilis	63	1.8
Gaura coccinea	63	0.1

Graminoids dominate this habitat type, and the summed forb and shrub coverage is less than that of the previous two habitat types (table 1). Soil textures of this habitat type range from loams to sandy loams. Other edaphic characteristics are shown in table A–26.

Others have described similar communities; Hurd (1961) described a *F. idahoensis/Lupinus sericeus* community in the Bighorn Mountains of north-central Wyoming where the undergrowth contained large

amounts of *Carex obtusata*. In the same area, Despain (1973) described a *F. idahoensis*-dominated community in which the major associates were *C. obtusata*, *Agoseris glauca*, and *Lupinus sericeus*. Mueggler and Stewart (1980) reported a *F. idahoensis/C. filifolia* habitat type generally confined to the higher elevations in southwestern Montana, and Wright and Wright (1948) identified a *F. idahoensis* community in south-central Montana.

Agropyron smithii/Carex filifolia

This habitat type occurs on nearly level upland depressions, gently sloping hillsides and on floodplains along the major streams. The *Agropyron smithii/Carex filifolia* habitat type is not widespread and is restricted to the eastern and central portions of the study region. In the 10 stands sampled, 64 species were recorded (table A–5). Nearly pure swards of *A. smithii* dominate undisturbed stands and *C. filifolia* and *Carex eleocharis* provide limited coverage. Constancy and mean coverage percentages of the major plants of the 10 stands sampled are as follows:

Species	Constancy (%)	Mean coverage (%)
Agropyron smithii	100	85.1
Bouteloua gracilis	50	4.1
Stipa viridula	50	3.4
Stipa comata	50	1.7
Carex filifolia	40	19.2
Carex eleocharis	40	5.4

In the present study, only 4 of the 64 species have constancies of 50% or more. The number of species per stand ranges from 3 to 29; the average was 12 species per stand.

Most stands of this habitat type are easily accessible to livestock, and because *A. smithii* is very palatable, many stands have numerous "weedy" species. Two stands sampled are relatively undisturbed. Stand 73, located on a floodplain of the South Fork of the Grand River in the Grand River District, is within a study exclosure established in 1961. Inside the exclosure, *A. smithii* has produced a luxuriant sward with a coverage of 98% (fig. 9). Other major species are *C. eleocharis* and *C. filifolia*. Outside the exclosure, the broad floodplain is severely overgrazed and *Bouteloua gracilis*, *Buchloe dactyloides*, and *Festuca octoflora* dominate the vegetation (fig. 10). Stand 8, also in an exclosure in the Grand River District, is on a gently sloping hillside. *A. smithii* is dominant with a coverage of 92%. *C. filifolia* and *Stipa viridula* have coverages of 70% and 12%, respectively. In this habitat type, graminoids again provide the greatest coverage (table 1).

Differences in abundances of *A. smithii* versus *S. comata* readily distinguish the *A. smithii/C. filifolia* and the *S. comata*-dominated vegetation. The *A. smithii/C. filifolia* plant association is an edaphic climax.

Soils of this habitat type range from clay loams to loams (table A–26). The clay content ranges from 12.0% to 38.6%. Fine-textured soils in this region generally have poor water balance, which explains, in part, the limited species diversity in undisturbed stands of this habitat type. *A. smithii*, however, thrives on heavy soils in the region (Weaver and Albertson 1956).

Figure 9.—*Agropyron smithii/Carex filifolia* habitat type in the Grand River District, Custer National Forest. This stand (73) has been protected from grazing since 1961.

Figure 10.—Heavy grazing outside of exclosure protecting stand 73 has eliminated nearly all of the *Agropyron smithii*. Stand is dominated by *Bouteloua gracilis*, *Buchloe dactyloides*, and *Festuca octoflora*.

Hansen et al. (1984) described this habitat type in Theodore Roosevelt National Park of western North Dakota, where the vegetation is an edaphic climax. Hanson and Whitman (1938) described a plant community in western North Dakota dominated by *A. smithii*, *Bouteloua gracilis*, and *C. filifolia* occurring on gradual slopes of fine-textured materials. Quinnild and Cosby (1958) found vegetation of mesa tops in western North Dakota dominated by *A. smithii*, *A. dasystachyum*, *S. comata*, *Bouteloua gracilis*, and *Artemisia frigida*. Larson and Whitman (1942) also reported an *Agropyron smithii*-dominated community on mesas in the badlands of South Dakota. Their results indicated that complete protection maintains a vegetation dominated by *A. smithii*, *C. filifolia*, and *C. eleocharis*, while combined mowing and grazing produces vegetation dominated by *B. gracilis*. Coupland (1950, 1961) described a community

in Canada dominated by *A. smithii* and *A. dasystachyum* occurring on fine-textured soils. Observations overall have been consistent in documenting the affinity of *A. smithii* for fine-textured soils.

Andropogon scoparius/Carex filifolia

This habitat type is restricted to the shoulders and slopes of buttes and hills (fig. 11). *Andropogon scoparius/ Carex filifolia* and *Fraxinus pennsylvanica/Prunus virginiana* are the only habitat types that occur throughout the study area. In the 16 stands sampled in this habitat type, 111 species were recorded (table A–6). With a mean coverage of 75.7%, *A. scoparius* dominates and characterizes the vegetation. *Bouteloua curtipendula, Echinacea angustifolia, Oxytropis lambertii, Psoralea argophylla,* and *Liatris punctata* are other important species in this union. The *C. filifolia, Agropyron smithii,* and *C. heliophila* unions also are represented. Dense layers of litter and duff usually cover the soil surface.

Twenty species had constancies of 50% or higher. Constancy and mean coverage percentages of major species are as follows:

Species	Constancy (%)	Mean coverage (%)
Andropogon scoparius	100	75.7
Carex filifolia	100	28.0
Koeleria pyramidata	88	1.3
Petalostemon purpureus	88	1.1
Artemisia frigida	88	0.4
Echinacea angustifolia	81	1.8
Aster ericoides	81	0.4
Oxytropis lambertii	75	0.6
Psoralea argophylla	75	0.4
Rosa arkansana	69	0.3
Liatris punctata	63	0.2
Bouteloua curtipendula	56	5.3
Lygodesmia juncea	50	0.2

Though forbs provide limited coverage (table 1), the numerous species add considerable diversity to the vegetation. Though forbs and shrubs are well represented, both growth forms provide less coverage than in the *Stipa comata/Carex filifolia* and *S. comata/C. heliophila* habitat types.

Figure 11.—*Andropogon scoparius/Carex filifolia* habitat type scattered across hillsides on the Grand River District southwest of Hettinger, North Dakota.

Figure 12.—*Calamovilfa longifolia/Carex heliophila* habitat type, southeast of Shadehill Reservoir, Grand River District, is restricted to sandy soils. Abrupt ecotones are typical where this habitat type adjoins another habitat type.

Soils range from loams to loamy sands (table A–26). Because of the topographic position and the generally coarse-textured soils, the *A. scoparius/ C. filifolia* habitat type is a topoedaphic climax.

Hansen et al. (1984) identified this habitat type in Theodore Roosevelt National Park of western North Dakota where the vegetation is a topoedaphic climax. Hanson and Whitman (1938) reported an *A. scoparius* community occurring on north-facing slopes and in open areas where snow accumulates. Redmann (1975) described a community on north-facing slopes dominated by *A. scoparius* in which *Rosa arkansana* and *Helianthus rigidus* also were important species. Jorgenson (1979) described a *Muhlenbergia cuspidata/A. scoparius* habitat type on loams and stoney loam soils derived from red shale in the Yellow Water Triangle, Montana.

Calamovilfa longifolia/Carex heliophila

This habitat type occurs in the eastern and central portions of the study region, and stands are limited in both size and extent. Typically, the stands are irregular in size and are scattered across the gently rolling landscape (fig. 12). Undisturbed vegetation in the *Calamovilfa longifolia/ Carex heliophila* habitat type consists of these two graminoids and very little else, although widely scattered individuals of *Bouteloua gracilis, Koeleria pyramidata,* and *Artemisia ludoviciana* may be present. *Calamovilfa longifolia* forms the dominant union, with its abundance and stature indicative of this association. The *Carex heliophila, Agropyron smithii,* and *C. filifolia* unions also are represented. Four stands were sampled with a total of only 33 species (table A–7), although 17 had constancies of 50% or higher.

Constancy and mean coverage percentages of major species in this association are as follows:

Species	Constancy (%)	Mean coverage (%)
Calamovilfa longifolia	100	94.6
Carex heliophila	100	84.1
Bouteloua gracilis	100	1.3
Koeleria pyramidata	100	0.3
Artemisia ludoviciana	75	2.1
Lygodesmia juncea	75	0.7
Poa pratensis	75	0.5
Artemisia frigida	75	0.3

In the *Calamovilfa longifolia/Carex heliophila* plant association, graminoids have the highest and forbs and shrubs the lowest mean coverages of all the steppe associations of this study (table 1).

Soils range from sandy loams to sands (table A–26). Sandy soils permit moderate to rapid water infiltration with little or no runoff, and deep-rooted mesophytic grasses like *Calamovilfa longifolia* more readily survive on sandy soils in this semiarid to arid environment. The *Calamovilfa longifolia/Carex heliophila* habitat type is an edaphic climax in the study region.

Hanson and Whitman (1938) identified a *Calamovilfa longifolia* community on sandy ridges and hills in western North Dakota. *Carex heliophila* also was an important species of this community. In western Canada, Coupland (1961) described stands of *Calamovilfa longifolia* that also occupied sandy soils.

Agropyron spicatum/Bouteloua curtipendula

Only three stands in this habitat type were sampled, but numerous others were observed. The *Agropyron spicatum/Bouteloua curtipendula* habitat type is restricted to the western portion of the study region, occurring on foothills and hillsides along major drainages (fig. 13). The slopes of the stands range from 25% to 55%. The plant association is dominated by *A. spicatum*; members of the *Andropogon scoparius* union also are present. The sites are dominated by the caespitose grass *Agropyron spicatum* and very little else, though widely scattered individuals of *B. curtipendula* are present. The vegetation

Figure 13.—*Agropyron spicatum/Bouteloua curtipendula* habitat type on a hillside in the Ashland District, southeastern Montana.

Figure 14.—*Agropyron spicatum/Carex filifolia* habitat type dominates an upland plateau on the Ashland District, Custer National Forest.

is similar to that of the *Rhus aromatica/Agropyron spicatum* habitat type, described below, except for the absence of *R. aromatica*. The *A. smithii* and *Carex filifolia* unions also are represented in the undergrowth. The soil surface usually contains large amounts of irregularly shaped, reddish, iron oxide porcelainite shale called scoria.

In the three stands sampled, 52 species were recorded (table A–8); 22 species had constancies of 50% or higher. Constancy and mean coverage percentages of major species are as follows:

Species	Constancy (%)	Mean coverage (%)
Agropyron spicatum	100	49.6
Bouteloua curtipendula	100	9.5
Lygodesmia juncea	100	0.5
Agropyron smithii	67	8.6
Andropogon scoparius	67	5.8
Carex filifolia	67	1.4
Echinacea angustifolia	67	0.8
Psoralea argophylla	67	0.3

Of all the steppe plant associations in this study, the *Agropyron spicatum/Bouteloua curtipendula* habitat type had the lowest graminoid coverage and the lowest total coverage (table 1).

Because of topographic and edaphic characteristics, the *A. spicatum/B. curtipendula* plant association is a topoedaphic climax. The soils are loams (table A–26).

Mueggler and Stewart (1980) described three *A. spicatum*-dominated habitat types in western Montana. The *A. spicatum/Bouteloua gracilis* habitat type, occurring east of the Continental Divide on the more southerly exposures, with slopes up to 35%, appears to be similar to the *A. spicatum/B. curtipendula* habitat type of this study.

Agropyron spicatum/Carex filifolia

Only two stands of this habitat type were sampled; its distribution is limited and it occurs only in the western portion of the study area. The sites occupy nearly level, relatively xeric, upland plateaus or buttes (fig. 14). The

vegetation is dominated by *Agropyron spicatum*, with limited coverage of *Carex filifolia*. The *A. spicatum*, *C. filifolia*, *A. smithii*, and *Stipa comata* unions are represented. Following disturbance, *Bromus japonicus* becomes established, and *Ambrosia psilostachya* and *Artemisia frigida* increase in abundance. In the two stands sampled, 39 species were recorded (table A–8). Constancy and mean coverage percentages of the major plants in the two stands are as follows:

Species	Constancy (%)	Mean coverage (%)
Agropyron spicatum	100	58.1
Carex filifolia	100	14.6
Bromus japonicus	100	12.3
Ambrosia psilostachya	100	8.0
Koeleria pyramidata	100	7.1
Stipa comata	100	4.1
Artemisia frigida	100	4.1
Bouteloua gracilis	100	0.7
Agropyron smithii	100	0.6
Carex eleocharis	100	0.2
Gaura coccinea	100	0.2

Graminoids provide the greatest cover, though forbs are relatively important (table 1).

Although species lists of the *Agropyron spicatum/Carex filifolia* and *A. spicatum/Bouteloua curtipendula* habitat types are similar, the difference in topographic positions and the absence of *B. curtipendula* in the former warrants separating these two habitat types. Soil textures for the two stands sampled are silt loams (table A–26). The *A. spicatum/C. filifolia* plant association is considered to be an edaphic climax.

Mueggler and Stewart (1980) described a *Liatris punctata* phase of an *Agropyron spicatum/Bouteloua gracilis* habitat type east of the Continental Divide in Montana. The phase is characterized by the presence of *L. punctata*, *C. filifolia*, and *Calamagrostis montanensis*, and it is similar to the *A. spicatum/Carex filifolia* habitat type of this study. In the Bighorn Mountains of north-central Wyoming, Despain (1973) described an *A. spicatum* community occurring on the western flank at lower elevations. Conspicuous species include *C. filifolia*, *Koeleria pyramidata*, and *Phlox hoodii*.

Shrub-Steppe Habitat Types

Artemisia tridentata/Agropyron spicatum

This habitat type occupies steep-to-moderate south-facing talus-covered slopes (fig. 15) to gentle footslopes along the major drainages in the western portion of the study region. Some stands are quite extensive and cover entire hillsides. In the five stands sampled, 53 species occurred (table A–9).

Relatively undisturbed stands of this habitat type are distinguished by the dominant shrub *Artemisia tridentata* and by *Agropyron spicatum* as the principal grass. *Koeleria pyramidata*, *Stipa viridula*, and *Agropyron smithii* may be present, but their summed coverages never equal that of *A. spicatum*. The vegetation consists of two well-defined layers. *Artemisia tridentata*, the only member of its union, averages 1.0 to 1.64 feet (3 to 5 dm) in height and dominates the upper layer. *Agropyron spicatum* dominates the lower layer along with other caespitose perennial grasses. *A. smithii* and *Carex filifolia* unions also may be represented. Soil surfaces usually are exposed in this habitat type.

Figure 15.—*Artemisia tridentata/Agropyron spicatum* habitat type on a moderate south-facing slope northeast of Birney, Montana, Ashland District. Dominance of *A. spicatum* in the undergrowth is evident.

In the five stands sampled, 16 species had constancies of 50% or higher. Constancy and mean coverage percentages of major species are as follows:

Species	Constancy (%)	Mean coverage (%)
Artemisia tridentata	100	21.2
Agropyron spicatum	100	40.1
Sphaeralcea coccinea	100	0.2
Koeleria pyramidata	80	5.0
Agropyron smithii	80	3.3
Artemisia frigida	80	0.4
Bouteloua gracilis	60	0.4

Shrubs and graminoids are most conspicuous in the *A. tridentata/A. spicatum* habitat type, and forbs are relatively sparse (table 1).

Severely disturbed stands of the *Artemisia tridentata/Agropyron spicatum* and the *Stipa comata/Carex heliophila* habitat types are similar. Both show increased amounts of *Artemisia frigida*, *Gutierrezia sarothrae*, *Achillea millefolium*, *Camelina microcarpa*, *Poa pratensis*, and *Bromus japonicus*. However, topographic position and the abundance of *Artemisia tridentata* distinguish these two habitat types.

The *Artemisia tridentata/Agropyron spicatum* plant association is a topographic climax. Soil textures of the five stands include loams, sandy clay loam, and sandy loam (table A–26).

Daubenmire (1970) described an *Artemisia tridentata/Agropyron spicatum* habitat type in the steppe of eastern Washington, occurring mostly on loams or stony loams. Daubenmire classified the vegetation as climatic climax and indicated it probably is the most extensive element in the steppe mosaic of eastern Washington. In western

Montana, Mueggler and Stewart (1980) identified an *Artemisia tridentata/Agropyron spicatum* habitat type that occurred on a variety of exposures, slopes, and soils. The vegetation differs from that in Washington in having the low shrubs *Artemisia frigida*, *Gutierrezia sarothrae*, and *Opuntia polyacantha*, and the grasses *Koeleria pyramidata* and *Bouteloua gracilis*. The forb components also differed. The *Artemisia tridentata/Agropyron spicatum* habitat type of this study is similar to that of western Montana. Mackie (1970), in north-central Montana, and Hironaka et al. (1983), in southern Idaho, described *Artemisia tridentata/Agropyron spicatum* habitat types which appear to be similar to that of western Montana and the present study. In eastern Montana, Brown (1971) described two communities restricted to talus slopes of southwest exposure dominated by *Artemisia tridentata* and *Agropyron spicatum*. In the Bighorn Mountains of Wyoming, Despain (1973) described a similar community occurring at lower elevations.

The *Artemisia tridentata/Agropyron spicatum* plant association described by Daubenmire (1970) for Washington is distinct from all others with the same name described for Montana and Idaho. These latter plant associations have species of the mid-continental steppe, as indicated above, which are lacking in this habitat type in Washington.

Artemisia tridentata/Agropyron smithii

This habitat type occurs on gently rolling upland topography in the western portion of the study region, with a limited number of stands in the central portion. Many of the stands are extensive and cover large areas of the landscape (fig. 16). Because of their position, the stands are easily accessible to livestock, and most sites show various degrees of disturbance. In the seven stands sampled, 50 species were recorded (table A–10).

Artemisia tridentata dominates the shrub layer and *Agropyron smithii* dominates the herbaceous layer in relatively undisturbed stands. *Koeleria pyramidata*, *Poa canbyi*, and *Stipa viridula* are additional important grasses of this association. The *Artemisia tridentata*, *Agropyron smithii*, and the *Carex filifolia* unions are represented. Physiognomically, the vegetation is identical to that of the *Artemisia tridentata/Agropyron spicatum* association; the herbaceous unions distinguish the two associations.

In the seven stands sampled, only 13 species had constancies of 50% or higher. Constancy and mean coverage percentages of major species are as follows:

Species	Constancy (%)	Mean coverage (%)
Artemisia tridentata	100	23.7
Agropyron smithii	100	39.2
Koeleria pyramidata	86	8.9
Poa canbyi	86	5.9
Bouteloua gracilis	86	2.4
Stipa viridula	71	6.7
Sphaeralcea coccinea	71	0.2
Artemisia frigida	57	0.5

Figure 16.—Ungrazed stand in the *Artemisia tridentata/Agropyron smithii* habitat type west of Diamond Butte, Ashland District, southeastern Montana. Note dominance of graminoids in the undergrowth.

Typically, the stands are open and much soil surface is exposed. Grazing reduces the coverage of major grass species, possibly confining them to areas directly beneath the shrub canopies. After severe disturbance, *Gutierrezia sarothrae*, *Bouteloua gracilis*, *Bromus japonicus*, *Achillea millefolium*, *Camelina microcarpa*, *Opuntia fragilis*, and *O. polyacantha* increase and palatable species decrease in abundance. Shrubs and graminoids are the most conspicuous growth forms in this habitat type, and forb coverages are the highest among the shrub-steppe habitat types (table 1).

Soil textures for the seven stands are loams and sandy clay loam (table A–26). The *Artemisia tridentata/Agropyron smithii* habitat type is considered to be an edaphic climax. *Artemisia tridentata* and *Agropyron smithii* also occur on heavy soils elsewhere (Tisdale and Hironaka 1981, Weaver and Albertson 1956).

In Theodore Roosevelt National Park of western North Dakota, this plant association is a topoedaphic climax on narrow benches or terraces above the valley floor of the Little Missouri River and its principal tributaries (Hansen et al. 1984). In north-central Montana, an *Artemisia tridentata/Agropyron smithii* plant association occurs as an edaphic climax on "shallow, gravelly, or claypan surface soils" (Mackie 1970). Other studies indicate broad vegetational similarities among *Artemisia tridentata*-dominated vegetation in western North Dakota (Hazlett and Hoffman 1975, Whitman and Hanson 1939).

Artemisia cana/Agropyron smithii

This habitat type occupies narrow floodplains and coalescing alluvial fans in valleys 98 to 820 feet (30 to 250 m) wide throughout the central and western portions of the study region (fig. 17). The *Artemisia cana/Agropyron smithii* habitat type is not extensive, but it is locally abundant. The stands are readily accessible to livestock and most show signs of disturbance. In the six stands sampled, 43 species were recorded (table A–11).

Artemisia cana dominates the shrub layer and *Agropyron smithii* dominates the herbaceous layer. *Stipa*

viridula also is important in undisturbed stands. *Artemisia cana* and *Agropyron smithii* unions are represented in this association. Following disturbance, *Poa pratensis*, *Bromus japonicus*, *Bouteloua gracilis*, *Achillea millefolium*, *Melilotus officinalis*, and *Taraxacum officinale* increase greatly, while *Agropyron smithii* and *S. viridula* decrease most noticeably. Palatable species still present in severely overgrazed stands are restricted to areas beneath the canopies of *Artemisia cana*.

In the six stands sampled, only 12 species had constancies of 50% or higher. Constancy and mean coverage percentages of major species are as follows:

Species	Constancy (%)	Mean coverage (%)
Artemisia cana	100	34.2
Agropyron smithii	100	72.0
Poa pratensis	100	20.7
Stipa viridula	100	5.4
Koeleria pyramidata	50	2.1

Shrubs and graminoids are the most conspicuous growth forms in this habitat type; forbs are sparse (table 1).

Though the sites may be contiguous, the *Artemisia cana/Agropyron smithii* habitat type is wetter than the *Artemisia tridentata/Agropyron smithii* habitat type, which may account for the greater coverage of graminoids in the former. On favorable sites, *Artemisia cana* often grows to 5 feet (1.5 m).

Soil textures for the six stands are loams (table A–26). Others have reported *Artemisia cana* occurring on medium-textured soils (Beetle and Johnson 1982, Hazlett and Hoffman 1975, Tisdale and Hironaka 1981). The *Artemisia cana/Agropyron smithii* plant association is considered to be an edaphic climax in the study region.

In Theodore Roosevelt National Park of western North Dakota, this habitat type also is an edaphic climax on floodplains and river terraces adjacent to the Little Missouri River and its tributaries (Hansen et al. 1984). Mueggler and Stewart (1980) described *Artemisia cana*-dominated communities occurring on deep, loamy, alluvial soils along some mountain streams at elevations usually over 5,994 feet (1,827 m) in southwestern Montana. The dominant grass was *Festuca idahoensis*. In

Figure 17.—*Artemisia cana/Agropyron smithii* habitat type, Long Pines, Sioux District, Custer National Forest. This habitat type usually occurs on deep, loamy, alluvial soils.

Figure 18.—*Juniperus horizontalis/Carex heliophila* habitat type on a steep north-facing hillside, Slim Buttes, Sioux District, Custer National Forest.

southern Idaho, Hironaka et al. (1983) described two minor *A. cana*-dominated habitat types, the *A. cana/F. idahoensis* habitat type along stream courses or in meadows where soil moisture is high, and the *A. cana/Muhlenbergia richardsonis* habitat type on poorly drained soils. The latter is more abundant farther west in Oregon and California.

Juniperus horizontalis/Carex heliophila

This habitat type occurs on steep north-facing slopes in the central portion of the study region. In the Slim Buttes and the Long Pines, many of the stands are quite extensive and cover entire hillsides (fig. 18). The *Juniperus horizontalis/Carex heliophila* habitat type is distinguished by the dominance of *J. horizontalis*, with a mean coverage of 81.9%, and the presence of *C. heliophila*, with a mean coverage of 20.4%. In the seven stands sampled, 67 species were recorded (table A–12).

The *J. horizontalis/C. heliophila* habitat type has a complex physiognomy. Members of the *J. horizontalis* union include the tall [up to 1.3 feet (4 dm)] *Agropyron dasystachyum* and the somewhat shorter *Thermopsis rhombifolia*, *Koeleria pyramidata*, and *Petalostemon purpureus*. *J. horizontalis*, which dominates the vegetation, is short-statured and hardly overtops members of the *C. heliophila* union. The tallest species is *Andropogon scoparius*, which has limited coverage but is conspicuous because of its height. The *Agropyron smithii* and *Carex filifolia* unions also are represented.

In the seven stands sampled, 32 species had constancies of 50% or higher. Constancy and mean coverage percentages of major species in this habitat type are as follows:

Species	Constancy (%)	Mean coverage (%)
Juniperus horizontalis	100	81.9
Carex heliophila	100	20.4
Andropogon scoparius	100	13.5
Carex filifolia	100	4.9
Thermopsis rhombifolia	100	2.4
Koeleria pyramidata	100	1.3

Campanula rotundifolia	100	0.8
Artemisia frigida	100	0.5
Agropyron dasystachyum	86	5.8
Anemone patens	86	1.4
Petalostemon purpureus	86	1.0
Symphoricarpos occidentalis	86	0.9
Galium boreale	86	0.7

Stands of the *Juniperus horizontalis/Carex heliophila* habitat type may be contiguous with those of *Andropogon scoparius/Carex filifolia*; other stands contact *A. scoparius*-dominated communities in which *C. heliophila* is abundant. Examples are stands 46 and 48 (table A–12); these are late-seral stages of the *J. horizontalis/C. heliophila* habitat type in which *A. scoparius* is abundant. As the stands mature, *J. horizontalis* forms a dense mat, *C. heliophila* increases, and *A. scoparius* decreases in importance.

Of the shrub-dominated habitat types, *J. horizontalis/C. heliophila* and *Sarcobatus vermiculatus/Agropyron spicatum* are the only ones in which the mean coverage of the shrubs exceeds that of the graminoids (table 1).

Soil textures of the seven stands are all sandy loams (table A–26). Ranges of sand content and organic matter content are 57.5% to 72.4% and 4.30% to 5.46%, respectively. On the basis of topographic and edaphic factors, the *J. horizontalis/C. heliophila* plant association is considered a topoedaphic climax.

In western North Dakota, the *J. horizontalis/Andropogon scoparius* plant association occurs as a topoedaphic climax where soil textures range from clay loam to loam (Hansen et al. 1984). Except for the abundance of *A. scoparius*, the presence of *Potentilla fruticosa*, and the absence of *C. heliophila* and *Agropyron dasystachyum*, the *J. horizontalis/Andropogon scoparius* and *J. horizontalis/C. heliophila* habitat types are similar. *J. horizontalis*-dominated vegetation also occurs in Alberta and in western North Dakota (Coupland 1961, Quinnild and Cosby 1958, Redmann 1975, Whitman and Hanson 1939).

Rhus aromatica/Agropyron spicatum

This habitat type occurs as patches or strips on convex shoulders and steep, xeric, south-facing hillsides (fig. 19). In the five stands sampled, the slopes exceeded 52%. Stands of the *Rhus aromatica/Agropyron spicatum* habitat type are limited in size and extent in the central portion but are more numerous in the western portion of the study area. The soils are rocky, and many sites have large amounts of reddish iron oxide porcelainite material. Ordinarily, considerable amounts of rock and mineral soil are exposed at the soil surface (table A–13). In the five stands sampled, only 47 species were recorded.

The shrub layer is dominated by *R. aromatica*, 1 to 2 feet (3 to 6 dm) tall, with 27% to 36% coverage. The herbaceous layer is dominated by *A. spicatum*, with limited amounts of *A. smithii* and *Bouteloua curtipendula*. The annual *Bromus tectorum* is infrequent. The more conspicuous forbs include *Sphaeralcea coccinea*, *Gaura coccinea*, *Ambrosia psilostachya*, and *Vicia americana*.

Figure 19.—*Rhus aromatica/Agropyron spicatum* habitat type on a steep south-facing hillside, Ashland District, southeastern Montana. Upslope stands in this habitat type adjoin either steppe- or *Pinus ponderosa*-dominated vegetation.

Except for the greater abundance of *R. aromatica*, the *R. aromatica/Agropyron spicatum* and *A. spicatum/Bouteloua curtipendula* associations are similar. The *R. aromatica*, *A. spicatum*, *A. smithii*, *Carex filifolia*, and *Andropogon scoparius* unions are all represented.

In the five stands sampled, only nine species had constancies of 50% or higher. Major species of this habitat type and their constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Rhus aromatica	100	30.0
Agropyron spicatum	100	39.8
Agropyron smithii	100	5.0
Bouteloua curtipendula	80	7.5
Sphaeralcea coccinea	80	0.5
Gaura coccinea	80	0.1

The lower sums of coverages in stands of the *Rhus aromatica/Agropyron spicatum* and the *Artemisia tridentata*-dominated plant associations reflect the more xeric nature of these habitat types (table 1).

This habitat type occupies a rather intermediate topographic position such that upslope it contacts either steppe or *Pinus ponderosa*-dominated vegetation, and downslope it contacts either steppe or *Artemisia tridentata*-dominated vegetation.

Soil textures range from sandy in the central part to loamy with much porcelainite in the western part of the study region (table A–26). Because of topographic and edaphic characteristics, the vegetation of the *Rhus aromatica/Agropyron spicatum* habitat type is considered to be a topoedaphic climax.

Mueggler and Stewart (1980) described the *R. aromatica/A. spicatum* habitat type in south-central Montana, where it occurs on south- and west-facing sedimentary benchlands or terraces of low-elevation breaks along major tributaries of the Missouri River. Their stands are similar in both physiognomy and vegetation to the stands sampled in the present study. In the Ashland District, Brown (1971) identified a *R. aromatica/A. spicatum* com-

munity located on and immediately below ridgetops; these stands probably represent the *R. aromatica/A. spicatum* habitat type described here.

Rhus aromatica/Festuca idahoensis

This infrequent habitat type occurs primarily as patches or strips on shoulders and slopes of gently rolling hillsides in the western portion of the study region (fig. 20). Considerable rock and mineral soil are exposed on the soil surface. Although the *Rhus aromatica/Festuca idahoensis* habitat type is wetter than the *R. aromatica/Agropyron spicatum* habitat type, both share numerous species and both are topoedaphic climaxes. *A. spicatum* may be more abundant than *F. idahoensis* in the *R. aromatica/F. idahoensis* habitat type, but *Festuca* is not present in stands of *R. aromatica/A. spicatum* habitat type, and this is primarily the basis for separation. Other conspicuous graminoids include *Carex heliophila, Poa canbyi,* and the introduced annual *Bromus japonicus.* This habitat type is dominated by members of the *F. idahoensis, A. spicatum, A. smithii, C. heliophila,* and *Andropogon scoparius* unions. In the two stands sampled, only 26 species were recorded (table A–13).

Characteristic species with constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Rhus aromatica	100	23.9
Festuca idahoensis	100	14.9
Agropyron spicatum	100	55.7
Bromus japonicus	100	19.2
Carex heliophila	100	12.7
Poa canbyi	100	7.8
Bouteloua curtipendula	100	2.0
Koeleria pyramidata	100	2.0
Aster ericoides	100	0.3
Agropyron smithii	100	0.2

Shrubs and graminoids are most conspicuous in the *R. aromatica/F. idahoensis* habitat type (table 1).

Figure 20.—*Rhus aromatica/Festuca idahoensis* habitat type on gently rolling hillsides, Ashland District, Custer National Forest. Note the wide spacing of *R. aromatica* in this stand.

Figure 21.—*Rhus aromatica/Carex filifolia* habitat type, Slim Buttes, Sioux District, Custer National Forest. *C. filifolia* provides 43% coverage in the undergrowth.

Stands of *R. aromatica/F. idahoensis* are readily accessible to livestock, and various levels of disturbance are apparent. Overgrazing usually reduces the abundance of *F. idahoensis* and *A. spicatum* and increases that of *Bromus japonicus, Gutierrezia sarothrae, Artemisia frigida, Ambrosia psilostachya,* and *Cerastium arvense.*

The soils are sandy loams (table A–26).

Mueggler and Stewart (1980) described a *R. aromatica/F. idahoensis* habitat type occurring along sedimentary benchlands or terraces above tributaries of the Yellowstone and Missouri Rivers in south-central Montana. Their stands of the habitat type are similar in both physiognomy and vegetation to these of the present study.

Rhus aromatica/Carex filifolia

This also is an infrequent habitat type that occurs as patches or strips on convex shoulders and moderate to steep slopes in the central portion of the study region (fig. 21). Locally abundant stands in the *Rhus aromatica/Carex filifolia* habitat type are found in the Slim Buttes area. Considerable amounts of rock and mineral soil are exposed on the soil surface.

The *R. aromatica/C. filifolia* habitat type is characterized by widely spaced *R. aromatica,* 1 to 2 feet (3 to 6 dm) tall, and by the low-growing *C. filifolia.* Other shrubs, such as *Artemisia frigida, Rosa arkansana,* and *Gutierrezia sarothrae,* may be present but have coverages of 5% or less. *C. filifolia,* the most abundant graminoid, is accompanied by the constant *Muhlenbergia cuspidata, Stipa comata, Koeleria pyramidata,* and *Agropyron dasystachyum.* Conspicuous forbs, but with very low coverage, are *Echinacea angustifolia, Petalostemon purpureus,* and *Phlox andicola.* Ordinarily, the graminoids *A. dasystachyum* and *C. heliophila* are restricted to areas under canopies of *R. aromatica.* Several unions are represented in this habitat type, including *R. aromatica, C. filifolia, Agropyron smithii, Stipa comata, Andropogon scoparius,* and the *Juniperus horizontalis.*

In the four stands sampled, 56 species were recorded (table A–14) and 30 species had constancies of 50% or

higher. Major species and their constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Rhus aromatica	100	25.1
Carex filifolia	100	43.3
Muhlenbergia cuspidata	100	14.1
Stipa comata	100	7.5
Artemisia frigida	100	4.0
Koeleria pyramidata	100	3.8
Agropyron dasystachyum	100	3.3
Artemisia dracunculus	100	0.6
Echinacea angustifolia	100	0.4
Petalostemon purpureus	100	0.3
Bouteloua gracilis	75	4.5

As in other *R. aromatica*-dominated habitat types, graminoids provide considerably more coverage than either shrubs or forbs (table 1).

The soil textures of the four stands are all sandy loams (table A–26). The *R. aromatica/C. filifolia* plant association is a topoedaphic climax.

Mueggler and Stewart (1980) reported no *R. aromatica/C. filifolia* from western Montana, and Hansen et al. (1984) found no *R. aromatica*-dominated vegetation in Theodore Roosevelt National Park.

Sarcobatus vermiculatus/Agropyron spicatum

The *Sarcobatus vermiculatus/Agropyron spicatum* habitat type is limited in both size and extent. This infrequent habitat type is restricted to contoured microbenches, 1 to 1.64 feet (3 to 5 dm) wide, on moderate to steep southwest- to southeast-facing hillsides in the western portion of the study region (fig. 22). The contouring microbenches result from nonuniform erosion of clay and silt shale layers. These are interspersed with occasional seams of lignite varying in thickness from a few centimeters to over a meter. The porous lignite seams cause subsurface water to move horizontally to the surface on the hillsides. The increased moisture content favors the development of the mesophytic *S. vermiculatus* on generally xeric sites.

Figure 22.—*Sarcobatus vermiculatus/Agropyron spicatum* habitat type on a contouring microbench, Ashland District, southeastern Montana.

The *S. vermiculatus/A. spicatum* vegetation consists of irregularly spaced *S. vermiculatus*, 2 to 3.28 feet (6 to 10 dm) in height, and a wide scattering of the caespitose *A. spicatum*. Coverage values for the two species are 25.8% and 16.3%, respectively (table A–15). Other shrubs present may include *Atriplex confertifolia*, *Artemisia tridentata*, and *Gutierrezia sarothrae*.

In the three stands sampled, only 14 species were recorded (table A–15) and six species had constancies of 67% or higher. Major species of the *Sarcobatus vermiculatus/Agropyron spicatum* habitat type and their constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Sarcobatus vermiculatus	100	25.8
Agropyron spicatum	100	16.3
Atriplex confertifolia	100	6.7
Artemisia tridentata	100	3.9
Gutierrezia sarothrae	67	1.4
Oryzopsis hymenoides	67	0.5

As indicated, shrubs are well represented in this habitat type. The *S. vermiculatus/A. spicatum* and the *Juniperus horizontalis/Carex heliophila* plant associations represent the only shrub-steppe vegetation in this study in which the shrub coverage exceeds the graminoid coverage. Forbs are most poorly represented, as shown by their low mean coverage value (table 1).

Typically, stands of *S. vermiculatus/A. spicatum* are contiguous with stands of the *Artemisia tridentata/Agropyron spicatum* habitat type. The steep hillsides limit the influence of cattle grazing.

Soil textures for the three stands are clay and clay loams. High amounts of exchangeable calcium and magnesium in the soils result in a high cation exchange capacity. The soils also have large amounts of rock and exposed lignite. In the stands sampled, the exposed soil surface ranges from 52% to 77%. Due to both topographic and edaphic characteristics, the plant association is a topoedaphic climax (table A–26).

Other investigators have described *S. vermiculatus*-dominated vegetation. In the badland vegetation in southeastern Montana, Brown (1971) described a community dominated by *S. vermiculatus* with *Artemisia tridentata*, *Suaeda fruticosa*, and *Atriplex confertifolia*, along with limited amounts of *Agropyron spicatum* present. In the steppe region of eastern Washington, Daubenmire (1970) identified a *S. vermiculatus/Distichlis spicata* habitat type occurring on saline-alkali soils. In western Montana, Mueggler and Stewart (1980) identified a *S. vermiculatus/Agropyron smithii* habitat type occurring on nearly level floodplains of rivers and streams, and a *Sarcobatus vermiculatus/Elymus cinereus* habitat type occupying concave toe slopes just above floodplains of rivers and streams.

Sarcobatus vermiculatus/Agropyron smithii

This habitat type occurs primarily on alluvial deposits of terraces, fans, and floodplains of the major streams

and rivers throughout the western portion of the study region (fig. 23). Many of the stands are quite extensive, covering large areas of the landscape. Only two stands were sampled but several others were observed. In the study area, ranch headquarters frequently are located on the floodplains and many sites in this habitat type are farmed or used as haylands. Other stands are readily accessible to livestock and most sites show various degrees of disturbance. The S. *vermiculatus*/*A. smithii* habitat type supports the fewest plant species of the habitat types identified in the present study. The S. *vermiculatus* and *A. smithii* unions only are represented in this plant association. In the two stands sampled, only 13 species were recorded (table A–15). S. *vermiculatus*, 2 to 3.28 feet (6 to 10 dm) in height, dominates the shrub layer and the rhizomatous *A. smithii* dominates the herbaceous layer. The palatable *A. smithii* and *Poa canbyi* decrease as a result of grazing, while *Bouteloua gracilis, Achillea millefolium, Camelina microcarpa, Opuntia polyacantha,* and the introduced annuals *Bromus japonicus* and *B. tectorum* all increase. Major species of this habitat type and their constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Sarcobatus vermiculatus	100	23.2
Agropyron smithii	100	50.3

Shrubs and graminoids are most conspicuous in the S. *vermiculatus*/*A. smithii* habitat type, and forbs are poorly represented (table 1).

Soil textures for the two stands are classified as loams (table A–26). Soils have relatively high pH values of 8.0 to 8.4, respectively. The S. *vermiculatus*/*A. smithii* plant association is an edaphic climax.

Mackie (1970) identified a S. *vermiculatus*/*A. smithii* habitat type in north-central Montana occurring on floodplains of the Missouri River and its major tributaries. In western Montana, Mueggler and Stewart (1980) described a S. *vermiculatus*/*A. smithii* habitat type occurring as narrow bands along floodplains of rivers and streams. Vegetation of the habitat type defined by Mueggler and Stewart is similar to that of the S. *vermiculatus*/*A. smithii* habitat type of the present study. Jorgenson (1979) described a S. *vermiculatus*/*Agropyron dasystachyum* habitat type on alluvial deposits on the Yellow Water Triangle, Montana in which *A. smithii* also was an important component of the undergrowth.

Figure 23.—*Sarcobatus vermiculatus/Agropyron smithii* habitat type on an alluvial deposit along a tributary of the Tongue River, Ashland District, southeastern Montana.

Figure 24.—Interior of a stand on the *Juniperus scopulorum/Agropyron spicatum* habitat type, Ashland District, Custer National Forest. Stands on this habitat type are characteristically open with limited undergrowth.

Woodland Habitat Types

Juniperus scopulorum/Agropyron spicatum

This habitat type occurs on moderate to steep north-facing slopes along the major drainages in the western portion of the study region. In the four stands sampled in the *Juniperus scopulorum/Agropyron spicatum* habitat type, the slopes ranged from 38% to 48%. Undisturbed stands are characterized by widely scattered individuals of *J. scopulorum*, 9.8 to 13.1 feet (3 to 4 m) in height, interspersed with the caespitose *A. spicatum* (fig. 24). The stands are open, and considerable amounts of rock and mineral soil are exposed at the soil surface (table A–16). *J. scopulorum* usually forms dense, irregular, pyramidal or conical crowns with many branches originating at or near the soil surface. In many stands, the main trunks of the larger trees were cut long ago for use as fenceposts. After disturbance, *Gutierrezia sarothrae, Symphoricarpos occidentalis, Achillea millefolium,* and *Cerastium arvense* increase in abundance. Erosional damage is evident in most of the stands.

In the four stands sampled, 62 species were recorded (table A–16) and 23 undergrowth species had constancies of 50% or higher. Major undergrowth species of this habitat type and their constancy and mean coverage percentages are as follows.

Species	Constancy (%)	Mean coverage (%)
Agropyron spicatum	100	28.2
Achillea millefolium	100	0.9
Cerastium arvense	100	0.6
Gutierrezia sarothrae	100	0.4
Symphoricarpos occidentalis	75	1.0
Bouteloua curtipendula	50	1.1

Compared to other plant associations studied, *J. scopulorum/A. spicatum* has the lowest undergrowth coverage, with values ranging from 32% to 55% (table 1).

Most stands show evidence of past fires. Young *J. scopulorum* is easily killed by fire because of small size, thin bark, and compact crown, and it does not resprout after a fire (Fischer and Clayton 1983, Wright et al. 1979). With thicker bark and less compact foliage, older *J. scopulorum* can be killed by a hot fire but can survive a cool fire. Mature *J. scopulorum* survived up to six separate fires in one study (Fischer and Clayton 1983). Sparse surface fuels reduce the chances of a damaging fire, but low spreading branches provide a route for fire to enter the crown and increase the potential for damage even in a cool fire.

The largest *J. scopulorum* sampled were in the 20– to 24–inch (5– to 6–dm) d.b.h class (table A–1); most trees were in the 8– to 12–inch (2– to 3–dm) d.b.h. class. Tree basal areas for these open stands ranged from 39.2 to 108.9 square feet per acre (9.0 to 25.0 m^2/ha). Many of the trees were more than 120 years old, and some were more than 390 years old.

Soil textures for the four stands are classified as clay loams and loams (table A–26). The *J. scopulorum/A. spicatum* plant association is a topographic climax.

Other investigators have described *J. scopulorum*-dominated vegetation (Alexander et al. 1986, Brown 1971, Hansen et al. 1984, Pfister et al. 1977, Steele et al. 1983); some have reported *J. scopulorum* as either a codominant or the major understory dominant (Brown 1971; Hoffman and Alexander 1976, 1983, 1987; Mackie 1970; Roberts and Sibbernsen 1979). In badlands of the Ashland District of the Custer National Forest, Brown (1971) described a *J. scopulorum/A. spicatum* community occurring in the deeper channels of side drainages. The physiognomy of the *J. scopulorum/A. spicatum* habitat type is similar to that of the *Pinus-Juniperus* stands of the Southwest, although *Pinus* is absent.

Juniperus scopulorum/Oryzopsis micrantha

This infrequent habitat type occurs on moderate to steep north-facing slopes of 30% to 65% in the central portion of the study region. Undisturbed stands have a closed overstory dominated by *Juniperus scopulorum*, 9.8 to 13.1 feet (3 to 4 m) in height, with *Oryzopsis micrantha* as the important undergrowth species; mosses and lichens may be locally abundant (fig. 25). *Agropyron spicatum* is absent from this habitat type. This plant association is characterized by the *J. scopulorum* and *O. micrantha* unions. The stands typically have considerable amounts of rock and mineral soil exposed at the soil surface. In the three stands sampled, 44 species were recorded (table A–17).

The physiognomy of the *J. scopulorum/O. micrantha* plant association differs from that of the *J. scopulorum/A. spicatum* in having a closed canopy. This difference is obvious in mean basal areas; 143.8 square feet per acre (33.0 m^2/ha) for the *J. scopulorum/O. micrantha* plant association and 81.5 square feet per acre (18.7 m^2/ha)

Figure 25.—Interior of a stand on the *Juniperus scopulorum/Oryzopsis micrantha* habitat type, Long Pines, Sioux District, Custer National Forest. *J. scopulorum* has produced a closed canopy in this stand.

for *J. scopulorum/A. spicatum* (table A–1). Additionally, the microclimate of the *J. scopulorum/O. micrantha* habitat type on mesic north-facing slopes is suitable for such mesophytic species as *O. micrantha*, *Campanula rotundifolia*, *Smilacina stellata*, *Galium boreale*, and abundant mosses and lichens.

Three stands were sampled in which 18 undergrowth species had constancies of 67% or higher. Constancy and mean coverage percentages of the major plants of this habitat type are as follows:

Species	Constancy (%)	Mean coverage (%)
Oryzopsis micrantha	100	46.2
Campanula rotundifolia	100	0.8
Mosses and lichens	67	14.4
Smilacina stellata	67	2.6
Galium boreale	67	0.1

Compared to other habitat types in this region, forbs are well represented, though graminoids provide the greatest coverage (table 1).

J. scopulorum/O. micrantha-dominated stands had 44 undergrowth species with coverage sums of 65% to 88% (table A–17). *J. scopulorum/A. spicatum*-dominated stands were richer with 62 species but had lower coverage sums of 33% to 55% (table A–16).

In many stands of the *J. scopulorum/O. micrantha* habitat type, larger trees have been cut and removed for fenceposts. Limited livestock grazing occurs, but owing to the steep slopes and the dense cover by *J. scopulorum*, the stands are used primarily by game species. There are numerous game trails throughout the stands, and *Achillea millefolium* and *Artemisia frigida* are most abundant along these trails. The shrubs *Berberis repens*, *Ribes cereum*, *Symphoricarpos albus*, *S. occidentalis*, and the graminoid *Carex heliophila* are considered accidental or seral species, and they occur most abundantly in the vicinities of openings in the *J. scopulorum* canopy. The largest *J. scopulorum* sampled was in the 12– to 16–inch (3– to 4–dm) d.b.h. class; most trees were in the 8– to 12–inch (2– to 3–dm) d.b.h. class (table A–1). Tree basal

areas for the stands varied from 98.4 to 181.2 square feet per acre (22.6 to 41.6 m^2/ha). Many of the trees were more than 100 years old, and some were more than 270 years old.

Soil textures of the three stands are loam and sandy loams (table A–26). Owing to its unique topographic position, the *Juniperus scopulorum/Oryzopsis micrantha* plant association is a topographic climax.

Hansen et al. (1984) described this habitat type in Theodore Roosevelt National Park of western North Dakota where, as a topographic climax, the association is abundant on moderate to steep northwest- to north-facing slopes. In the North Dakota study, the undergrowth coverage sums ranged from 127% to 204% compared to 65% to 85% in the present study. The mean coverage values for mosses plus lichens were 72.5% and 14.4% in the North Dakota and present study, respectively. The lower values in this study reflect the influence of a slightly drier environment and the possible influences of both livestock and humans.

Fraxinus pennsylvanica/Prunus virginiana

In the northern Great Plains where zonal soils support steppe vegetation, woodland vegetation is confined to stream courses or to other positions in the landscape where combinations of soil and topography permit greater than average accumulation of moisture. The *Fraxinus pennsylvanica/Prunus virginiana* habitat type occurs in upland ravines and broad valleys or moderately steep slopes throughout the study area (fig. 26). It also occurs along small permanent or ephemeral streams.

In the 14 stands sampled, 90 species were recorded (table A–18). The tree stratum is dominated by the *F. pennsylvanica* union, which includes *Acer negundo* and *Ulmus americana*. In sharply cut, V-shaped upland ravines, the largest *F. pennsylvanica* are near the center or bottom of the ravine where there is greater soil moisture. In relatively undisturbed stands, the undergrowth is comprised of two layers. The taller and more conspicuous layer is 6.6 to 9.8 feet (2 to 3 m) in height and is composed chiefly of *P. virginiana*, with a mean coverage of 52.8%. Its abundance and stature are indicative of the *F. pennsylvanica/P. virginiana* plant association (fig. 27). Other members of the *P. virginiana* union are *Rosa woodsii*, *Amelanchier alnifolia*, and *A. sanguinea*. *Carex sprengelii* and *Elymus virginicus* dominate the lowest layer, with mean coverages of 31.8% to 14.1%, respectively. Other members of the *C. sprengelii* union characteristic of this vegetation are *Agropyron caninum*, *Thalictrum dasycarpum*, *T. venulosum*, *Smilacina stellata*, *Galium aparine*, and *Parietaria pennsylvanica*. Along the fringes of these stands, *Prunus virginiana* frequently forms dense ecotonal thickets before giving way to steppe vegetation higher on the slopes. In characterizing this habitat type, samples must be taken well within the mature overstory woodland vegetation, because not only are many stands very narrow, but the moisture gradient upslope onto adjacent steppe is quite steep. Sampling from the center of the *F. pennsylvanica*-dominated stand upslope toward the steppe can obliterate recognition of the rather distinct ecotones separating the long, narrow strips of vegetation.

Figure 26.—Occurrence of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type within the general landscape, Grand River District, Custer National Forest.

Figure 27.—Interior of an undisturbed stand of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type. The undergrowth is a rich mixture of shrubs and herbaceous species.

In the central and western portions of the study region, *Crataegus succulenta* is abundant in many stands, and observations along fence lines of exclosures indicate it increases following overgrazing by livestock.

Fourteen stands were sampled, with only 12 undergrowth species having a constancy of 50% or higher. Constancy and mean coverage percentages of the major species of the *F. pennsylvanica/P. virginiana* plant association are as follows:

Species	Constancy (%)	Mean coverage (%)
Prunus virginiana	93	52.8
Carex sprengelii	100	31.8
Elymus virginicus	86	14.1
Smilacina stellata	86	3.0
Galium aparine	79	6.3
Agropyron caninum	71	4.4
Parietaria pennsylvanica	64	1.4
Thalictrum dasycarpum	64	0.7
Rosa woodsii	50	1.0

The means of shrub, graminoid, and forb coverages are shown in table 1.

Of the 14 stands sampled, stands 7, 9, 27, 28, 84, 110, and 115 are located within exclosures. The *F. pennsylvanica/P. virginiana* vegetation is rich in shrubs (26 species). The mean coverage of shrubs in the exclosures was 103.0%, the mean for all 14 stands was 78.9%, and the mean for stands not in exclosures was 57%. In contrast, the values for the graminoids and forbs were nearly identical.

The largest *F. pennsylvanica* sampled was in the 20– to 24–inch (5– to 6–dm) d.b.h. class (table A–1) and was 114 years. Tree basal area for the 14 stands ranged from 67.5 to 195.2 square feet per acre (15.5 to 44.8 m^2/ha). The average age of *F. pennsylvanica* was 70 to 80 years. However, heartrot prevented determining the ages of many of the larger trees. Soil textures are clay loams, loams, sandy clay loam, and sandy loam (table A–26). The *F. pennsylvanica/P. virginiana* plant association is a topoedaphic climax.

Hansen et al. (1985) described this habitat type for Theodore Roosevelt National Park of western North Dakota. This report is the first recognition of the *F. pennsylvanica/P. virginiana* habitat type in either Montana or South Dakota.

In the northern Great Plains, upland woodlands and forests are important in the overall landscape mosaic, even though they represent a very small fraction of the total area. Located in areas of greater than normal moisture, they are more productive than the surrounding steppe vegetation (Thomas et al. 1979). They add to the overall diversity of the vegetation. They also attract wildlife and domestic animals for the thermal cover, nesting habitat, moisture, browse species, and protection they afford (Ames 1977, Hansen et al. 1985, Severson and Boldt 1978). Because of this, these woodlands and forests are focal points for some of the livestock and wildlife management conflicts in this region.

Livestock grazing has had adverse effects on these sites for both wildlife and vegetation maintenance. Heavy cattle grazing significantly reduces bird species composition and foraging guilds, as well as small mammal density and diversity (Kauffman and Krueger 1984). Livestock grazing also influences soil compaction and bulk density. Alderfer and Robinson (1949), Bryant et al. (1972), Orr (1960), and Rauzi and Hanson (1966) all found soil compaction increased linearly with increases in grazing intensity.

Livestock grazing of these upland woodlands resulted in reduced coverage and some changes in the species composition (fig. 28). In this study, three heavily grazed stands of this habitat type were sampled (table A–19). In all three, the shrub species were greatly reduced. The mean shrub coverage of 79% in undisturbed stands contrasts with 10% in the heavily grazed stands, where most of the coverage was the unpalatable *Symphoricarpos occidentalis*. Mean graminoid coverage of 75% in undisturbed stands contrasts to 10% in disturbed stands, most of which consists of *Poa pratensis*. Overall, the sum of the mean coverages of shrubs, graminoids, and forbs was 187% in undisturbed stands compared to 123% in

Figure 28.—Interior of a disturbed stand of the *Fraxinus pennsylvanica/Prunus virginiana*. Many shrubs have been severely browsed or eliminated and tree reproduction sharply reduced.

Figure 29.—Severe overgrazing has eliminated most of the undergrowth and tree reproduction in this stand of the *Fraxinus pennsylvanica/Prunus virginiana* habitat type. Undergrowth in this open stand is now dominated by *Symphoricarpos occidentalis* and *Poa pratensis*.

heavily grazed stands (tables A–18 and A–19). In the three grazed stands, 42 species were recorded; 10 species had constancies of at least 67%. Major species in these three stands are as follows:

Species	Constancy (%)	Mean coverage (%)
Poa pratensis	100	83.1
Symphoricarpos occidentalis	100	5.5
Stipa viridula	100	3.1
Achillea millefolium	100	1.8
Bromus japonicus	100	0.6
Agropyron caninum	67	10.1
Monarda fistulosa	67	0.7

The continued decline in the understory shrubs, tree seedlings, and saplings eventually results in a stand of only older trees, a very open understory, and a low shrub and herbaceous layer (fig. 29). Reducing the seedling-sapling component of the overstory species can only result eventually in a decline of the tree population, opening the stand to greater insolation at the ground surface,

and increasing reproduction of heliophytic herbaceous species. Indeed, "former" woodlands have been observed in this state of decadence. Others apparently have observed the same phenomenon elsewhere (Crouch 1979, Richard and Cushing 1982). Intense cattle grazing reduces the value of this resource for further cattle grazing or wildlife, as indicated above.

Populus tremuloides/Berberis repens

This infrequent habitat type occurs in upland ravines, on moderately steep slopes, and along small permanent or ephemeral streams in the central portion of the study region; small isolated stands may be found in the eastern and western portions (fig. 30). Most stands are on north exposures. In the four stands sampled, 59 species were recorded (table A–20). The *Populus tremuloides/Berberis repens* habitat type is recognized by the consistent presence and reproductive success of *P. tremuloides*, the only member of its union, and the abundance and dominance of the *B. repens* union in the undergrowth. Other members of the *B. repens* union include *Symphoricarpos albus*, *Rubus idaeus*, *Toxicodendron rydbergii*, and *Ribes missouriense*. The *Prunus virginiana* and the *Carex sprengelii* unions also are represented. Because of livestock grazing, *Poa pratensis* also is abundant in this habitat type. Other important forbs include *Galium boreale* and *Smilacina stellata*.

Four stands were sampled, with 30 undergrowth species having constancies of 50% or higher. Major species of this habitat type and their constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Berberis repens	100	45.4
Poa pratensis	100	36.1
Galium boreale	100	5.8
Prunus virginiana	100	5.1
Symphoricarpos albus	100	4.4
Rubus idaeus	100	2.3
Toxicodendron rydbergii	100	1.2
Ribes missouriense	100	0.7
Smilacina stellata	100	0.2
Carex sprengelii	75	8.8
Elymus virginicus	75	5.3
Thalictrum dasycarpum	75	1.4
Amelanchier alnifolia	50	0.6
Amelanchier sanguinea	50	0.5

The *P. tremuloides/B. repens* plant association is rich in shrubs; 19 species were recorded. Graminoids and forbs also are well represented (table 1).

There has been considerable discussion regarding the role of *P. tremuloides* in the West as both a climax and a seral species, and both assessments may be correct. There is sufficient evidence that *P. tremuloides* invades or is established on favorable sites after fire (Hoff 1957; Hoffman and Alexander 1976, 1980, 1983, 1987; Morgan 1969; Mueggler and Bartos 1977; Mueggler and Campbell 1982, 1984; Severson and Thilenius 1976; Youngblood and Mueggler 1981). In some areas, *P. tremuloides* dominates sites where fires have destroyed coniferous forests, and, in time, the conifers gradually replace *P. tremuloides*. On other sites, *P. tremuloides* forests appear to be self-perpetuating climax without evidence of conifer invasion.

Figure 30.—*Populus tremuloides/Berberis repens* habitat type in the Ekalaka Hills, Sioux District, Custer National Forest. *P. tremuloides* occurs in diameter classes ranging from 0–1 to 3–4 dm.

In the study area, stands of the *P. tremuloides/B. repens* habitat type apparently are stable with *P. tremuloides* present in all size classes (table A–1). In other stands, *Fraxinus pennsylvanica* or *Acer negundo* may be widely scattered. The presence of *F. pennsylvanica* or *A. negundo* seems to indicate past disturbance. For example, in stands 53 and 54, abundant *F. pennsylvanica* and *A. negundo* occur near openings of the canopy caused by windthrow of the taller *P. tremuloides*. Immediately after disturbance, *F. pennsylvanica*, *A. negundo*, and *P. tremuloides* all produce abundant seedlings and/or root suckers. The canopy eventually is closed by *P. tremuloides*, and numerous seedlings and/or saplings of *F. pennsylvanica* and *A. negundo* die. In stands 53 and 54, there were 29 and 133 dead trees, respectively, of *F. pennsylvanica* and/or *A. negundo*. This is interesting because both *F. pennsylvanica* and *A. negundo* reproduce adequately in their own shade to replace their numbers in the overstory. *P. tremuloides* obviously is an effective competitor in this habitat type. A few scattered saplings of *F. pennsylvanica* or *A. negundo* may survive to maturity and reproduce following future disturbances.

Stands of the *P. tremuloides/B. repens* habitat type are accessible to livestock that move in for the same reasons indicated for the *F. pennsylvanica/Prunus virginiana* habitat type. Abundant *Poa pratensis* is the result of grazing disturbance in the *P. tremuloides/B. repens* habitat type.

The largest *P. tremuloides* sampled was in the 12– to 16–inch (3– to 4–dm) d.b.h. class (table A–1). Tree basal areas for the four stands ranged from 139.0 to 230.4 square feet per acre (31.9 to 52.9 m^2/ha). Most of the trees were more than 60 years old, and few were more than 95 years old. However, heartrot made age determination difficult in many of the larger *P. tremuloides*. The soil textures are sandy loams (table A–26). The *P.*

tremuloides/B. repens plant association is considered to be a topographic climax.

P. tremuloides forests with somewhat similar undergrowth vegetation occur in the Black Hills National Forest (Hoffman and Alexander 1987). In western North Dakota, Hansen et al. (1984) described a *P. tremuloides/Betula occidentalis* habitat type that shares many of the common undergrowth species except *Betula occidentalis* and *Berberis repens*. Throughout the Rocky Mountain West, others have defined a similar *P. tremuloides/Symphoricarpos oreophilus* habitat type with *B. repens* prominent in the undergrowth (Hoffman and Alexander 1980, 1983; Reed 1971). Mueggler and Campbell (1982, 1984) and Youngblood and Mueggler (1981) described a *P. tremuloides/S. oreophilus* community type for southeastern Idaho, Utah, and western Wyoming, and indicated it probably was stable and very likely a habitat type.

Forest Habitat Types

In the study area, *Pinus ponderosa* forests are relatively uncommon, and where they occur, they form a mosaic with steppe, shrub-steppe interspersed (fig. 31). In the western part of the region, *P. ponderosa* is more common and some of the stands are extensive.

Pinus ponderosa/Agropyron spicatum

The *Pinus ponderosa/Agropyron spicatum* habitat type commonly occurs on moderate to steep south-facing slopes in the western portion of the study region; infrequent stands also occur in the central portion. This habitat type is the most xeric of those dominated by *P. ponderosa*. The slope position of this habitat type varies from a band along the summit of hills to an entire hillside (fig. 32). The soils are commonly coarse-textured or rocky, and many have large amounts of reddish iron oxide porcelainite material. Considerable amounts of rock and mineral soil usually are exposed on the soil surface. In relatively undisturbed stands, widely spaced *P. ponderosa* occupies the tallest layer; an occasional Juniperus scopulorum may be present. The *Agropyron spicatum*, *Carex heliophila*, and *Andropogon scoparius* unions characterize the sparse undergrowth. *Agropyron spicatum* is most conspicuous, and *Carex heliophila*, *Rhus aromatica*, and *Bouteloua curtipendula* provide limited coverage.

Figure 31.—General view of typical scattered *Pinus ponderosa* stands, Ashland District, southeastern Montana.

Figure 32.—*Pinus ponderosa/Agropyron spicatum* habitat type on a steep south-facing slope, Ashland District, Custer National Forest. Undergrowth is dominated by graminoids.

In the three stands sampled, 48 species were recorded (table A–21, appendix 2); only nine undergrowth species had constancies of 50% or higher. Major species of the *P. ponderosa/A. spicatum* habitat type and their constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Agropyron spicatum	100	32.4
Carex heliophila	100	14.7
Bouteloua curtipendula	67	1.4

Overall, the vegetation of this warm, dry habitat type is rather sparse; graminoids are most conspicuous (table 1).

Except for the dominance of *P. ponderosa*, this habitat type is similar in vegetation and topographic position to both the *A. spicatum/Bouteloua curtipendula* and the *Rhus aromatica/A. spicatum* habitat types. *P. ponderosa* seedlings establishing in some steppe locations currently dominated by *A. spicatum* indicate a possible succession to *P. ponderosa*. The history of this steppe is not known; it is possible that *P. ponderosa* once occurred here and was eliminated by fire, logging, grazing, or a combination of these.

The largest *P. ponderosa* sampled was in the 24– to 28–inch (6– to 7–dm) d.b.h. class (table A–1). The basal areas for the three stands sampled ranged from 134.6 to 160.3 square feet per acre (30.9 to 36.8 m^2/ha). The low basal areas reflect the xeric microclimate and the open vegetation. Many of the trees were more than 100 years old, and some were more than 200 years old. Soil textures are loamy sand, sandy loam, and sand (table A–26). The *P. ponderosa/A. spicatum* plant association is considered to be a topoedaphic climax.

A *P. ponderosa/A. spicatum* habitat type has been described for eastern Washington and northern Idaho

(Daubenmire and Daubenmire 1968), the Bighorns of north-central Wyoming (Hoffman and Alexander 1976), north-central Montana (Mackie 1970), central Montana (Jorgenson 1979), the Crow and Northern Cheyenne Indian Reservations in southeastern Montana (Cooper and Pfister 1984), other locations in Montana (Pfister et al. 1977), and central Idaho (Steele et al. 1981.

Pinus ponderosa/Festuca idahoensis

Only two stands of this habitat type were sampled, although numerous others were observed. The *Pinus ponderosa/Festuca idahoensis* habitat type occurs on gently rolling upland topography in the western portion of the study region and is not as dry as the *P. ponderosa/Agropyron spicatum* habitat type. In relatively undisturbed stands of this habitat type, widely spaced *P. ponderosa* occupy the overstory layer interspersed with an occasional *Juniperus scopulorum*. The undergrowth is characterized by the *Festuca idahoensis* and *Carex heliophila* unions (fig. 33). In the two stands sampled, 37 species were recorded (table A–22). The presence of *P. ponderosa* distinguishes this from the *F. idahoensis/C. heliophila* habitat type. The two habitat types usually are contiguous and separated by an abrupt ecotone. Constancy and mean coverage percentages of the major plants in the two stands sampled are as follows:

Species	Constancy (%)	Mean coverage (%)
Festuca idahoensis	100	41.2
Carex heliophila	100	24.5
Antennaria rosea	100	0.7

Graminoids dominate the undergrowth of this habitat type, forbs provide limited coverage, and shrubs are rare (table 1).

Many stands in this habitat type show evidence of past fire. The *P. ponderosa/F. idahoensis* habitat type occurs on gentle terrain, and many stands have been managed intensively for either timber or forage production. The largest *P. ponderosa* sampled was in the 24– to 28–inch (6– to 7–dm) d.b.h. class (table A–1). Basal areas for the two stands were 153.3 square feet per acre (35.2 m^2/ha) and 188.2 square feet per acre (43.2 m^2/ha). As in the *Pinus/Agropyron* vegetation, low basal areas reflect the open nature of the vegetation. Many of the trees were at least 120 years old, and some were more than 190 years old.

Figure 33.—*Pinus ponderosa/Festuca idahoensis* habitat type on nearly level upland topography, Ashland District, southeastern Montana. Graminoids dominate the undergrowth.

Although tree reproduction is more consistent over time than in the *P. ponderosa/Agropyron spicatum* habitat type, it still is episodic. Stands of both the *P. ponderosa/F. idahoensis* and the *P. ponderosa/C. heliophila* habitat types (discussed below) are mosaics of dense patches of trees ("dog hair" stands), each distinctive in height and age. When young, the dense trees eliminate the undergrowth vegetation beneath them. Later, as the tree population becomes thinner and the canopy more elevated, herbaceous vegetation appears. In mature stands, the patches become so open that the trees have little influence on the steppe-like undergrowth.

Much of the soil surface usually is covered with litter and duff. Soil textures of the two stands are loam and sandy loam (table A–26). The *P. ponderosa/F. idahoensis* plant association is an edaphic climax.

A *P. ponderosa/F. idahoensis* habitat type has been described for eastern Washington and northern Idaho (Daubenmire and Daubenmire 1968), for the Bighorns of north-central Wyoming (Hoffman and Alexander 1976), for the Crow and Northern Cheyenne Indian Reservations in southeastern Montana (Cooper and Pfister 1984), for Montana (Pfister et al. 1977), and for central Idaho (Steele et al. 1981). In the Montana study, Pfister et al. (1977) described a *F. idahoensis* phase that is similar to the *P. ponderosa/F. idahoensis* habitat type of the present study.

Pinus ponderosa/Carex heliophila

This habitat type occurs on gently rolling upland topography in the central and western portion of the study area. The *Pinus ponderosa/Carex heliophila* habitat type is the most mesic of the graminoid-dominated *P. ponderosa* habitat types. In relatively undisturbed stands of this habitat type, *P. ponderosa* produces a closed overstory, while the *C. heliophila* union dominates the undergrowth (fig. 34). An occasional *Juniperus scopulorum* may be present. *Agropyron spicatum* is present, but the *Festuca idahoensis* union is not well represented, and the *Juniperus communis* union is absent. Based on both vegetation and physiognomy, the *P. ponderosa/C. heliophila* and *P. ponderosa/F. idahoensis* habitat types are similar. In the three stands sampled, 34 species were recorded (table A–22).

In the three stands sampled, only five undergrowth species had constancies of 50% or higher. Major species of this habitat type and their constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Carex heliophila	100	74.9
Agropyron spicatum	100	1.1

Undergrowth of the *P. ponderosa/C. heliophila* habitat type is dominated by graminoids; forbs and shrubs are poorly represented (table 1).

Many of the stands in this habitat type show evidence of past fire. In the central portion, and to a limited degree in the western portion, of the study region, *P. ponderosa* is becoming established in stands of *Andropogon scoparius/C. heliophila* habitat type. These stands appear to represent seral stages of the *P. ponderosa/C. heliophila* habitat type rather than stands of the *A. scoparius/C. filifolia* habitat type. In these situations, *P. ponderosa* is not "invading" the *Andropogon*-dominated grassland, but is reestablishing on sites where it occurred before it was eliminated by fire. Continuous grazing since then has maintained the areas as steppe. As succession proceeds, *A. scoparius* and other heliophytes are eliminated within the shade of individual trees. The stands eventually become dominated by *P. ponderosa* and *C. heliophila*. This interpretation is based on our observations though it is possible that the climate may be changing to allow *P. ponderosa* to move into certain areas of steppe. No attempt was made to trace long-term climatic changes.

Pfister et al. (1977) described a *P. ponderosa/Andropogon* spp. habitat type occurring as a minor one in southeastern Montana in which the undergrowth is dominated by *A. scoparius* and *A. gerardii*. They reported that it occurs rarely in the Ashland District of the Custer National Forest (where one stand was sampled), but indicated that this habitat type is more common eastward in the Long Pines of the Sioux District in the Custer National Forest near the Montana-South Dakota border. In their work in southeastern Montana, Cooper and Pfister (1984) reported that the *P. ponderosa/Andropogon* spp. habitat type was only found on the eastern and southern edges of the Northern Cheyenne Indian Reservation as small and disturbed stands that preclude their being sampled. Pfister et al. (1977) reported that this habitat type replaces both the *P. ponderosa/Agropyron spicatum* and the *P. ponderosa/Festuca idahoensis* habitat types in an eastward direction toward the Black Hills, where Thilenius (1972) described a similar "habitat unit" called *P. ponderosa/Andropogon scoparius*. Based on data from the Custer National Forest and on the work of Hoffman and Alexander (1987) in the Black Hills National Forest, the *P. ponderosa/Andropogon* spp. vegetation is neither climax nor a habitat type. In the study area, this vegetation probably is seral to either the *P. ponderosa/Carex heliophila* or the *P. ponderosa/Agropyron spicatum* plant association.

Figure 34.—*Pinus ponderosa/Carex heliophila* habitat type on gently rolling upland topography, Ekalaka Hills, Sioux District, Custer National Forest. Dominance of *C. heliophila* in the undergrowth is evident.

The episodic tree reproduction in this habitat type is much the same as that described for the *P. ponderosa/F. idahoensis* habitat type. Owing to the gentle terrain, many stands of *P. ponderosa/C. heliophila* have been managed intensively for forage and/or timber production. The largest *P. ponderosa* sampled was in the 20– to 24–inch (5– to 6–dm) d.b.h. class (table A–1). Tree basal areas for the three stands ranged from 202.6 to 243.9 square feet per acre (46.5 to 56.0 m^2/ha), reflecting somewhat wetter conditions of this habitat type. Many of the trees were more than 100 years old; some were more than 178 years old. The soil textures are sandy loams and loamy sands (table A–26). The *P. ponderosa/C. heliophila* plant association is considered to be an edaphic climax.

The *P. ponderosa/C. heliophila* habitat type was not reported in Montana, the Bighorns of Wyoming, or central Idaho (Hoffman and Alexander 1976, Pfister et al. 1977, Steele et al. 1981). It does occur in the Black Hills National Forest (Hoffman and Alexander 1987). As indicated, it also shows similarities to the *P. ponderosa/Andropogon* spp. "habitat type" described by Pfister et al. (1977) and the *P. ponderosa/Andropogon scoparius* "habitat unit" described by Thilenius (1972). It also is similar to the *P. ponderosa/Festuca idahoensis* habitat type of the present study.

Pinus ponderosa/Juniperus communis

Only two stands of this habitat type were sampled; others were observed. The *Pinus ponderosa/Juniperus communis* habitat type occurs on gently rolling upland topography to moderately steep hillsides in the central portion of the study region. In stands that are relatively free of disturbance, the *P. ponderosa* union forms a nearly closed overstory, and the *J. communis* and *Carex heliophila* unions characterize the undergrowth (fig. 35). Species of the *Berberis repens* and the *Prunus virginiana* unions also are present. In the two stands sampled, only 28 undergrowth species were recorded (table A–23).

Constancy and mean coverage percentages of the major undergrowth plants in the two stands are as follows:

Species	Constancy (%)	Mean coverage (%)
Juniperus communis	100	39.6
Carex heliophila	100	26.0
Berberis repens	50	0.4
Amelanchier alnifolia	50	0.2
Prunus virginiana	50	0.1
Symphoricarpos albus	50	0.1

Shrubs are more constant and provide more coverage than other growth forms, though only two stands were

sampled. Graminoids provide considerably less coverage than shrubs, but much greater coverage than forbs (table 1).

Due to the gentle terrain, many stands of the *P. ponderosa/J. communis* habitat type have been managed intensively for forage and/or timber production. Following disturbance, *Prunus virginiana*, *Danthonia spicata*, and, to a lesser extent, *Berberis repens* quickly invade the site or increase their abundance only to decrease with time and lack of disturbance. The presence of *J. communis* is key in identifying this habitat type, and it is readily killed by fire. Before birds or other natural agents have ensured dissemination of *J. communis* seeds over a burned area of this habitat type, other shrubs may dominate the undergrowth. *Prunus virginiana* may be abundant. Seral stands in the *Pinus ponderosa/J. communis* habitat type may be mistaken for the *Pinus ponderosa/Prunus virginiana* habitat type (see below).

Trees have reproduced regularly, apparently, judging from the tree population data in table A–1. Many seedlings were present in both stands. The largest *Pinus ponderosa* sampled was in the 24– to 28–inch (6– to 7–dm) d.b.h. class (table A–1). Tree basal areas for the two stands were 237.4 square feet per acre (54.5 m^2/ha) and 243.9 square feet per acre (56.0 m^2/ha). Many of the trees were more than 100 years old, and a few were more than 220 years old.

The soil surface generally is covered with litter and duff. The soil textures are classified as sandy loams (table A–26). The *P. ponderosa/J. communis* plant association is an edaphic climax.

A habitat type with similar undergrowth vegetation was not reported for Montana (Pfister et al. 1977), though it was for the Bighorn Mountains of Wyoming (Hoffman and Alexander 1976). In the Black Hills of South Dakota and Wyoming, Thilenius (1972) described a *P. ponderosa* "habitat unit" dominated by *J. communis*, *Symphoricarpos albus*, and *Berberis repens*. Hoffman and Alexander (1987) reported a *P. ponderosa/J. communis* habitat type occurring on the limestone plateau region of the northwestern and western portions of the Black Hills National Forest.

Figure 35.—*Pinus ponderosa/Juniperus communis* habitat type on a gentle hillside, Ekalaka Hills, Sioux District, Custer National Forest. Undergrowth in this stand is characterized by widely spaced *J. communis* with a coverage of 40%.

Pinus ponderosa/Prunus virginiana

This habitat type commonly occurs on moderate to steep north-facing slopes and close to streams in the central and western portions of the study region; a limited number of stands occupy gently rolling upland terrain in the central portion. *Pinus ponderosa/Prunus virginiana* is the wettest of the *Pinus ponderosa*-dominated plant associations. In the five stands sampled, 59 species were recorded (table A–24). Tree populations vary; in some stands all size classes of trees are present, in other stands only two or three size classes of trees are present (table A–1). In undisturbed vegetation of this habitat type, *Pinus ponderosa* forms a closed overstory; two shrub unions characterize the undergrowth. The *Prunus virginiana* union is taller and more conspicuous and composed chiefly of *Prunus virginiana*, approximately 3.28 feet (1 m) in height, with some *Amelanchier alnifolia* and *Rosa woodsii* also present (fig. 36). As a result of browsing, *Prunus virginiana* and *A. alnifolia* may be shorter and produce many stems (fig. 37). The *Berberis repens* union forms the lower and less conspicuous shrub union; other members include *Ribes missouriense*, *Symphoricarpos albus*, and *Toxicodendron rydbergii*. *Agropyron caninum*, *Schizachne purpurascens*, *Galium boreale*, and *Smilacina stellata* are important herbaceous species. *Carex heliophila* may be abundant in stands on gently rolling uplands. The *Juniperus communis* union is absent in this habitat type.

Five stands were sampled and 16 undergrowth species had constancies of 50% or higher. Major species of the *Pinus ponderosa/Prunus virginiana* habitat type and their constancy and mean coverage percentages are as follows:

Species	Constancy (%)	Mean coverage (%)
Prunus virginiana	100	43.5
Amelanchier alnifolia	100	6.2
Galium boreale	100	4.0
Berberis repens	80	26.0
Toxicodendron rydbergii	80	6.2
Agropyron caninum	80	4.3
Rosa woodsii	80	3.6
Schizachne purpurascens	80	2.6
Ribes missouriense	80	1.1
Smilacina stellata	80	0.8
Carex heliophila	60	20.3
Symphoricarpos albus	60	1.2

The relatively high coverages reflect the mesic conditions associated with this habitat type (table 1).

Most stands showed evidence of past fires. Many of the common undergrowth species of this habitat type regenerate from subterranean organs following fire. Other plants must reestablish from seeds so their presence in seral stands is controlled, in part, by the distance of seed sources. Though aerial plant parts may be consumed during fire, *Prunus virginiana*, *Amelanchier alnifolia*, and *Symphoricarpos albus* resprout from surviving root crowns or rhizomes and usually increase their coverage following fire. *Berberis repens* is

moderately resistant and survives all but severe fires that both remove the duff and heat the upper soil for extended periods. The forb *Apocynum androsaemifolium* also sprouts after fire. Following a cool to moderate fire, *B. repens*, *A. androsaemifolium*, and *S. albus* sprout quickly and increase their abundance. As succession advances, these species decrease in importance, usually adjusting to prefire conditions, while *Prunus virginiana* and, to a lesser extent, *Amelanchier alnifolia* slowly increase. In addition, scattered seedlings or saplings of *Fraxinus pennsylvanica* and *Crataegus succulenta* may be found at this time. *F. pennsylvanica* and *C. succulenta* usually do not survive past saplings in the older stands, and none were sampled in our stands of this habitat type. However, mature individuals of *F. pennsylvanica* and *C. succulenta* may occur close to streams in this habitat type.

The largest *Pinus ponderosa* sampled was in the 24– to 28–inch (6– to 7–dm) d.b.h. class (table A–1). Tree basal area for the five stands ranged from 159.4 to 276.6 square feet per acre (36.6 to 63.5 m^2/ha). This is the highest basal area value for *P. ponderosa*-dominated habitat types, possibly reflecting the mesic conditions of this habitat type. Many of the trees were more than 100 years old, and some were more than 210 years old. The soil textures are loam and sandy loam (table A–26). The *Pinus ponderosa/Prunus virginiana* plant association is an edaphic climax.

Figure 36.—*Pinus ponderosa/Prunus virginiana* habitat type on a moderately steep north-facing slope, Ashland District, southeastern Montana. Undergrowth is dominated by *P. virginiana*, *Amelanchier alnifolia*, *Berberis repens*, *Rosa woodsii*, and *Toxicodendron rydbergii*.

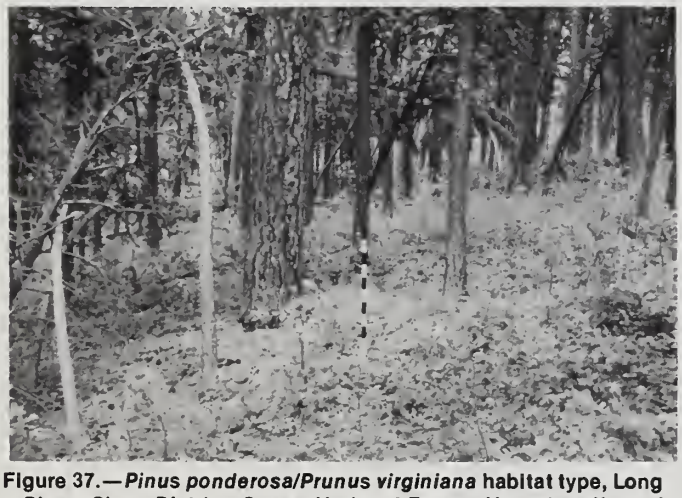

Figure 37.—*Pinus ponderosa/Prunus virginiana* habitat type, Long Pines, Sioux District, Custer National Forest. Note the effect of heavy browsing on *P. virginiana* and *Amelanchier alnifolia*.

Pfister et al. (1977) and Cooper and Pfister (1984) described a *Pinus ponderosa/Prunus virginiana* habitat type for southeastern Montana. In the Bighorn Mountains of Wyoming and the Black Hills National Forest of South Dakota and Wyoming, Hoffman and Alexander (1976, 1987) described a *Pinus ponderosa/Physocarpus monogynus* habitat type that shares many species with the *Pinus ponderosa/Prunus virginiana* habitat type. At the northern edge of the Black Hills south of the study area, a few stands of a *Pinus ponderosa/Prunus virginiana* community also occur (Hoffman and Alexander 1987).

Community Types

Symphoricarpos occidentalis

This community type occurs as scattered thickets throughout the study region. It is recognized by the dominant rhizomatous shrub *Symphoricarpos occidentalis*, which forms dense irregularly shaped thickets up to 3.28 feet (1 m) in height (fig. 38). *S. occidentalis* has a wide ecological amplitude, adapted to most soil textures, tolerant of imperfectly drained soils but not prolonged flooding or a permanently high water table, and tolerant of both weakly basic and weakly acidic soils (Pelton 1953, Wasser 1982). In the northern Great Plains, the species is common on mesic sites, including swale-like depressions, upland ravines, and floodplains along streams and rivers. Although it thrives in nearly full sunlight, it also tolerates the moderate shade of open forests or woodlands. It is grazing- and fire-tolerant and it increases on disturbed areas (Pelton 1953, Wasser 1982). It is strongly competitive and, in dense colonies, it often excludes other vegetation. In Minnesota, Pelton (1953) found it to move into areas of steppe and shade-out herbaceous species. Trees then established on the same areas. In the present study, these thickets were considered a community type, subject to change, because there is insufficient data to consider them other than a community type.

Although only two stands were sampled, numerous others were observed. The stands are readily accessible to livestock, and most sites show various degrees of disturbance. However, the two stands sampled are located in exclosures. Typically, the *S. occidentalis* community type has three layers: an upper layer, 1.64 to 3.28 feet (0.5 to 1.0 m) tall, dominated by *S. occidentalis*; an intermediate layer, 0.7 to 1.64 feet (0.2 to 0.5 m) tall, dominated by the introduced *Poa pratensis*; and a lower layer, 0.3 to 1.0 feet (0.1 to 0.3 m) tall, dominated by *Parietaria pennsylvanica*, *Galium boreale*, and *Artemisia ludoviciana* (table A–25). Disturbance opens the dense shrub canopy allowing forbs and graminoids to invade. Stands of this community type typically occur on sites much the same as those occupied by the *Fraxinus penn-*

Figure 38.—Dense thicket of *Symphoricarpos occidentalis* in an exclosure, Grand River District, Custer National Forest.

Figure 39.—Scattered thickets of *Shepherdia argentea* along an ephemeral stream, Grand River District, Custer National Forest.

sylvanica/*Prunus virginiana* habitat type and may be a seral stage of this habitat type. However, if the *Symphoricarpos* thickets are seral, they appear to be long-lived, and the climax vegetation is unknown.

This community type was described by Hansen et al. (1984) for western North Dakota. Thickets of *S. occidentalis* community type in steppe vegetation also have been described elsewhere (Daubenmire 1970, Mackie 1970).

Shepherdia argentea

This community type occurs as scattered thickets in the eastern and central portions of the study region; a limited number of stands also were observed in the western portion. The community type is recognized by the dominance of the spine-tipped shrub *Shepherdia argentea*, which forms dense, nearly impenetrable thickets often exceeding 6.56 feet (2 m) in height (fig. 39). *S. argentea* has a wide ecological amplitude adapted to most soil textures, but is more commonly found in well-drained medium- to coarse-textured soils. The shrub is tolerant of slightly acid to mostly basic saline soils (Wasser 1982). In the northern Great Plains, *S. argentea* occurs on mesic sites, such as swales and ravines, along ephemeral streams, and on hillsides with a northerly exposure. *S. argentea* thrives in full sunlight but may occur in shaded locations.

Eleven stands of the *S. argentea* community type were sampled (table A–25). Relatively undisturbed vegetation of this community type is characterized by a dense overstory of *S. argentea*; beneath is a scattering of *Poa pratensis* and *Parietaria pennsylvanica*. Along the edges of the stands is a rich mixture of woodland and steppe species. In some instances, *Symphoricarpos occidentalis* forms dense ecotonal thickets surrounding the stands. Livestock and deer frequent the thickets and establish numerous trails throughout. The disturbance opens the stands for the invasion of such species as *S. occidentalis*, *Toxicodendron rydbergii*, *Achillea millefolium*, *Artemisia ludoviciana*, *Monarda fistulosa*, *Nepeta cataria*, and *Taraxacum officinale*.

Shepherdia argentea stands occupy sites similar to the *Fraxinus pennsylvanica*/*Prunus virginiana* habitat type (fig. 39). While *Shepherdia*-dominated communities were classified as a community type, data to indicate the dynamics of these communities are limited. They occupy sites that appear similar to *F. pennsylvanica*/*P. virginiana* sites (compare figures 26 and 39), but calculated similarities between the *S. argentea* communities and those dominated by *F. pennsylvanica* are inconclusive. Using the Jaccard index of similarity, a 54% similarity was found between *S. argentea* communities and relatively undisturbed *F. pennsylvanica* communities. The *S. argentea* and undisturbed *F. pennsylvanica* communities were each 43% similar to the disturbed *F. pennsylvanica* communities. However, in a limited number of stands, widely scattered individuals of *F. pennsylvanica* were observed. Others also have described *S. argentea* thickets in the northern Great Plains (Boldt et al. 1978, Nelson 1961, Severson and Boldt 1978).

The soil textures are classified as loams, sandy loams, and loamy sands (table A–26).

Key to the Habitat Types

1. Tree species absent; graminoids, shrubs, and forbs dominant.
   2. Graminoids dominant; shrubs and forbs may be present.
      3. *Stipa comata* and/or *Agropyron smithii* dominant; *Agropyron cristatum* also may be present and abundant.
         4. *Agropyron smithii* usually dominant; if *Agropyron smithii* is absent or inconspicuous, then *Buchloe dactyloides* and *Bouteloua gracilis* are abundant and dominant. *Stipa comata* absent or inconspicuous. ..... *Agropyron smithii/Carex filifolia* h.t.
         4. *Stipa comata* dominant; *Agropyron smithii* present but not dominant.
            5. *Carex filifolia* dominates the undergrowth; *Carex heliophila* absent or not abundant ..... *Stipa comata/Carex filifolia* h.t.
            5. *Carex heliophila* dominates the undergrowth; *Carex filifolia* absent or not abundant ..... *Stipa comata/Carex heliophila* h.t.
      3. *Stipa comata* and/or *Agropyron smithii* absent or not dominant.
         6. *Festuca idahoensis* or *Agropyron spicatum* well represented.
            7. *Festuca idahoensis* dominant; *Agropyron spicatum* absent or inconspicuous ..... *Festuca idahoensis/Carex heliophila* h.t.
            7. *Agropyron spicatum* dominant; *Festuca idahoensis* absent or inconspicuous.
               8. *Bouteloua curtipendula* present and abundant; *Carex filifolia* may be present but not abundant ..... *Agropyron spicatum/Bouteloua curtipendula* h.t.
               8. *Carex filifolia* abundant; *Bouteloua curtipendula* absent ..... *Agropyron spicatum/Carex filifolia* h.t.
         6. *Festuca idahoensis* and *Agropyron spicatum* absent or inconspicuous.
            9. *Calamovilfa longifolia* abundant; *Andropogon scoparius* absent ..... *Calamovilfa longifolia/Carex heliophila* h.t.
            9. *Andropogon scoparius* dominant; *Calamovilfa longifolia* inconspicuous or absent ..... *Andropogon scoparius/Carex filifolia* h.t.
   2. Shrubs dominant; graminoids and forbs usually present.
      10. *Artemisia tridentata* or *Artemisia cana* present and conspicuous; other shrubs absent or rare.
         11. *Artemisia tridentata* dominant; *Artemisia cana* absent or inconspicuous.
            12. *Agropyron spicatum* dominant in the low undergrowth; *Agropyron smithii* inconspicuous or absent ..... *Artemisia tridentata/Agropyron spicatum* h.t.
            12. *Agropyron smithii* dominant in the undergrowth; *Agropyron spicatum* absent or inconspicuous ..... *Artemisia tridentata/Agropyron smithii* h.t.
         11. *Artemisia cana* dominant; *Artemisia tridentata* absent or very sparse ..... *Artemisia cana/Agropyron smithii* h.t.
      10. *Artemisia tridentata* and *Artemisia cana* absent or inconspicuous.
            13. *Juniperus horizontalis* or *Rhus aromatica* well represented.
               14. *Juniperus horizontalis* dominant; *Rhus aromatica* absent or inconspicuous ..... *Juniperus horizontalis/Carex heliophila* h.t.
               14. *Rhus aromatica* dominant; *Juniperus horizontalis* absent.
                  15. *Carex filifolia* abundant; *Agropyron spicatum* and/or *Festuca idahoensis* absent ..... *Rhus aromatica/Carex filifolia* h.t.
                  15. *Agropyron spicatum* and/or *Festuca idahoensis* well represented; *Carex filifolia* absent or inconspicuous.
                     16. *Agropyron spicatum* well represented; *Festuca idahoensis* absent ..... *Rhus aromatica/Agropyron spicatum* h.t.
                     16. *Festuca idahoensis* present and conspicuous; *Agropyron spicatum* also may be present ..... *Rhus aromatica/Festuca idahoensis* h.t.
            13. *Juniperus horizontalis* and *Rhus aromatica* absent or inconspicuous.
                  17. *Sarcobatus vermiculatus* or *Shepherdia argentea* abundant; *Symphoricarpos occidentalis* absent or not dominant.
                     18. *Sarcobatus vermiculatus* dominant; *Shepherdia argentea* absent.
                        19. *Agropyron smithii* abundant; *Agropyron spicatum* absent ..... *Sarcobatus vermiculatus/ Agropyron smithii* h.t.
                        19. *Agropyron spicatum* abundant; *Agropyron smithii* absent or inconspicuous ..... *Sarcobatus vermiculatus/ Agropyron spicatum* h.t.
                     18. *Shepherdia argentea* present; *Sarcobatus vermiculatus* absent ..... *Shepherdia argentea* c.t.
                  17. *Symphoricarpos occidentalis* abundant; *Sarcobatus vermiculatus* or *Shepherdia argentea* absent ..... *Symphoricarpos occidentalis* c.t.

1. Tree species dominant; shrubs, graminoids, and forbs usually present.
   20. Coniferous tree species present and dominant; deciduous trees absent or rare.
      21. *Juniperus scopulorum* dominant and reproducing sufficiently; *Pinus ponderosa* may be present but is neither dominant nor reproducing sufficiently to maintain its population structure.
         22. *Agropyron spicatum* dominates undergrowth; *Oryzopsis micrantha* absent or inconspicuous ... . *Juniperus scopulorum/Agropyron spicatum* h.t.
         22. *Oryzopsis micrantha* dominates undergrowth; *Agropyron spicatum* absent or rare .... *Juniperus scopulorum/Oryzopsis micrantha* h.t.
      21. *Pinus ponderosa* dominant and reproducing; *Juniperus scopulorum* may be present but not reproducing sufficiently to become dominant.
         23. Shrubs dominate the undergrowth; graminoids may be present but not dominant.
            24. *Prunus virginiana* well represented; *Juniperus communis* absent .... *Pinus ponderosa/Prunus virginiana* h.t.
            24. *Juniperus communis* present and dominant; *Prunus virginiana* also may be present but not dominant ..... *Pinus ponderosa/Juniperus communis* h.t.
         23. Graminoids dominate the undergrowth; shrubs may be present but not abundant.
            25. *Carex heliophila* dominates undergrowth. *Agropyron spicatum* or *Festuca idahoensis* may be present but not abundant ..... *Pinus ponderosa/Carex heliophila* h.t.
            25. *Carex heliophila* may be present but not abundant in undergrowth. *Agropyron spicatum* or *Festuca idahoensis* dominates undergrowth.
               26. *Agropyron spicatum* dominates undergrowth; *Festuca idahoensis* absent or rare ..... *Pinus ponderosa/Agropyron spicatum* h.t.
               26. *Festuca idahoensis* dominates undergrowth; *Agropyron spicatum* absent or not abundant ..... *Pinus ponderosa/Festuca idahoensis* h.t.
   20. Deciduous trees dominant and reproducing; coniferous trees absent or rare, not reproducing sufficiently.
            27. *Fraxinus pennsylvanica* dominant and reproducing; *Populus tremuloides* absent ..... *Fraxinus pennsylvanica/Prunus virginiana* h.t.
            27. *Fraxinus pennsylvanica* absent or present in seedling and sapling size only; an occasional mature tree may be present; *Populus tremuloides* dominant and reproducing sufficiently to maintain its population structure .... *Populus tremuloides/Berberis repens* h.t.

Discussion

The Habitat Type Classification

Natural vegetation that develops over a long period of time without disturbance reflects the biotic potential of the landscape. Vegetation characteristics of natural vegetation, therefore, are convenient in developing an ecological classification of landscapes in which not only vegetation but also climate, soil, and disturbance factors are taken into account (Daubenmire 1976, Daubenmire and Daubenmire 1968).

A classification scheme provides a systematic ordering of the landscape units under study. In the present study, the units are the habitat types, and the method of defining and delimiting these provides as natural a classification as possible. The concept of habitat types is that landscapes can be categorized into units of similar biotic potential and that understanding succession and the indicator values of certain individual species is essential to this effort. Studies are being done to establish relationships between the basic habitat type concept and the applied values in resource management. Other studies have centered on productivity and grazing potentials (Mueggler and Stewart 1980), wildlife utilization (Hansen et al. 1984, Hironaka et al. 1983, Mackie 1970), small mammal distributions (Hoffman 1960, Rickard 1957), growth rates of trees (Daubenmire 1961, Rioux 1984), the role of fire in forest succession (Fischer and Clayton 1983), and silvicultural and watershed management implications (Hoffman and Alexander 1976, 1980, 1983, 1987). The use of habitat type maps is becoming an important management tool by providing a permanent record of habitat type distributions and a basis for total area estimates for land-use planning (Pfister et al. 1977; Steele et al. 1981, 1983).

The present classification and the key to identify the habitat types has been tested in the field.[4] The key was found to be useful and reliable. As with most keys written for habitat type identification, it works best in stands of older, relatively undisturbed vegetation. However, the key was developed to anticipate various degrees of disturbance. Where overgrazing has removed most of the palatable and, in some cases, dominant species, nearby less disturbed sites will have to be relied on for the presence of indicator species. In other cases, for example, *Rhus aromatica*-dominated habitat types, position of the landscape will have to be relied on to help separate the heavily grazed stands. In addition, the determination made can be verified by using the key to check the written descriptions of the habitat types.

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Species Richness

The median numbers of shrubs, graminoids, and forbs in the stands of each habitat type are given in table 2. Species richness generally is highest in the woodland- and steppe-dominated habitat types and lowest in the forest- and shrub-steppe-dominated habitat types. Among the steppe habitat types, species diversity ranged from a low of 13 in the *Agropyron smithii/Carex filifolia* habitat type to a high of 28 in the *Agropyron spicatum/C. filifolia* habitat type. In Theodore Roosevelt National Park of western North Dakota, the *A. smithii/C. filifolia* habitat type also showed the lowest species diversity of the steppe habitat types (Hansen et al. 1984). Species diversity among the shrub-steppe habitat types ranged from a low of 8 in the *Sarcobatus vermiculatus*-dominated habitat types to a high of 34 in the *Juniperus horizontalis/Carex heliophila* habitat type, which is the highest species diversity for the present study. Stands of the *J. horizontalis/C. heliophila* habitat type occupy relatively cool and mesic north-facing slopes. This is undoubtedly an important factor influencing species diversity in the semi-arid climate of the northern Great Plains. A similar *J. horizontalis/Andropogon scoparius* habitat type also had the highest species diversity in an earlier study in western North Dakota (Hansen et al. 1984). Species diversity among the woodland habitat types ranged from 21 in the *Juniperus scopulorum/Oryzopsis micrantha* habitat type to 26 in the *Populus tremuloides/Berberis repens* habitat type where wetter conditions probably account for more species. These numbers of species in woodland habitat types compare favorably with those of western North Dakota (Hansen et al. 1984). Among the forest habitat types, species diversity ranged from 10 in the *Pinus ponderosa/Carex heliophila* habitat type to 21 in the *P. ponderosa/Prunus virginiana* habitat type.

Species diversity among all habitat types ranged from a low of 8 in the two *Sarcobatus vermiculatus*-dominated habitat types to a high of 34 in the *Juniperus horizontalis/Carex heliophila* habitat type. The *J. horizontalis/C. heliophila* habitat type also had the highest forb diversity with 20. With the exception of the three graminoid-dominated forest habitat types, the woodland and forest habitat types generally had more shrubs than the steppe and shrub-steppe habitat types.

Table 2.—Species richness of undergrowth vegetation in the habitat types of the Custer National Forest.

Habitat type	Median number of undergrowth species[1]				Number of stands sampled
	Shrubs	Graminoids	Forbs	Total	
Steppe					
Stipa comata/Carex filifolia	1	9	15	25	18
Stipa comata/Carex heliophila	2	9	15	26	10
Festuca idahoensis/Carex heliophila	3	10	10	23	8
Agropyron smithii/Carex filifolia	1	9	3	13	10
Andropogon scoparius/Carex filifolia	2	7	9	18	16
Calamovilfa longifolia/Carex heliophila	1	7	8	16	4
Agropyron spicatum/Bouteloua curtipendula	3	8	15	26	3
Agropyron spicatum/Carex filifolia	2	11	15	28	2
Shrub-Steppe					
Artemisia tridentata/Agropyron spicatum	4	8	9	21	5
Artemisia tridentata/Agropyron smithii	2	6	7	15	7
Artemisia cana/Agropyron smithii	2	5	5	12	6
Juniperus horizontalis/Carex heliophila	5	9	20	34	7
Rhus aromatica/Agropyron spicatum	3	7	5	15	5
Rhus aromatica/Festuca idahoensis	3	10	8	21	2
Rhus aromatica/Carex filifolia	4	8	16	28	4
Sarcobatus vermiculatus/Agropyron spicatum	4	3	1	8	3
Sarcobatus vermiculatus/Agropyron smithii	1	5	2	8	2
Woodland					
Juniperus scopulorum/Agropyron spicatum	4	8	12	24	4
Juniperus scopulorum/Oryzopsis micrantha	6	6	9	21	3
Fraxinus pennsylvanica/Prunus virginiana	8	5	10	23	14
Populus tremuloides/Berberis repens	9	6	11	26	4
Forest					
Pinus ponderosa/Agropyron spicatum	2	7	9	18	3
Pinus ponderosa/Festuca idahoensis	1	6	11	18	2
Pinus ponderosa/Carex heliophila	1	5	4	10	3
Pinus ponderosa/Juniperus communis	5	5	2	12	2
Pinus ponderosa/Prunus virginiana	7	7	7	21	5

[1]*Based on fifty 0.1 m^2 microplots per stand.*

Management Implications

A habitat type classification provides a permanent and ecologically based system of land stratification in terms of vegetational potential (Daubenmire 1976). As the habitat type is the basic unit in classifying land units or sites based on their biotic potential, it emphasizes similarities and differences in ecosystems that carry implications for a variety of land management objectives (Daubenmire 1984). Habitat types provide a tool for categorizing research results, administrative study results, and accumulated field observations. The classification scheme also provides a basis for predicting the response of vegetation to management-related activities. Habitat types will complement information on existing vegetation, soils, outdoor recreation, hydrology, and wildlife, and will aid development of more intensive land-management planning and practices.

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Appendix 1. Tree Population Analysis

Tree population analyses of the Grand River, Sioux, and Ashland Districts. Population structure of trees in stands, by habitat types. Numbers of trees listed per 375 m^2, with basal area for the stands as m^2/ha. Districts are abbreviated as follows: G = Grand River/Cedar River, S = Sioux, A = Ashland. Abbreviations of tree species are as follows: Acne = *Acer negundo*, Frpe = *Fraxinus pennsylvanica*, Jusc = *Juniperus scopulorum*, Pipo = *Pinus ponderosa*, Potr = *Populus tremuloides*, Ulam = *Ulmus americana*.

Table A-1.—Population of trees by habitat type.

No. of stands	Mean basal area	Species	Diameter (at breast height) classes in dm							
			<0.5	>0.5-1	1-2	2-3	3-4	4-5	5-6	6-7
		Juniperus scopulorum/Agropyron spicatum habitat type								
4	18.7	Jusc	188	26	21	2			(1)	
		Juniperus scopulorum/Oryzopsis micrantha habitat type								
3	32.7	Jusc	195	45	31	7	1			
		Fraxinus pennsylvanica/Prunus virginiana habitat type								
14	29.1	Frpe	89	9	18	6	1	1	(1)	
		Acne	22	(1)	1	(1)	(1)			
		Ulam	(1)			(1)	(1)		(1)	
		Disturbed Stands								
		Fraxinus pennsylvanica/Prunus virginiana habitat type								
3	20.7	Frpe	12[2]		5	7	2	(1)		
		Acne	2[2]			1				
		Populus tremuloides/Berberis repens habitat type								
4	40.4	Potr	274	6	32	8	2			
		Frpe	148	7	2		(1)			
		Acne	7		(1)					
		Pipo	1	1						
		Pinus ponderosa/Agropyron spicatum habitat type								
3	33.6	Pipo	5	4	6	6	5		(1)	(1)
		Pinus ponderosa/Festuca idahoensis habitat type								
2	39.2	Pipo	118	9	10	7	4	(1)	(1)	(1)
		Pinus ponderosa/Carex heliophila habitat type								
3	52.3	Pipo	156	9	17	10	7	2	(1)	
		Jusc	3							
		Pinus ponderosa/Juniperus communis habitat type								
2	55.2	Pipo	242	10	22	12	2	(1)	(1)	(1)
		Pinus ponderosa/Prunus virginiana habitat type								
5	48.9	Pipo	391	9	17	9	3	2	1	(1)

[1] *Less than one tree per plot.*
[2] *Root suckers or stem-base suckers, rather than seedlings. All showed moderate to heavy browse damage.*

Appendix 2. Habitat Type and Community Type Tables with Stand Data

In the plant data, the number to the left of the slash is percent coverage where the value exceeds 0.5%; a + to the left of the slash indicates coverage of 0.5% or less. Number to the right of slash is percent frequency; species present in the macroplot but not in the microplots are indicated by *. Stand numbers, Ranger Districts, locations, and topographic positions also are given for each habitat type. Only the mean values of all plots are given for the community types. Districts are abbreviated as follows: Grand River/Cedar River District—G, Sioux District—S, Ashland District—A.

Table A-2.—*Stipa comata/Carex filifolia* habitat type.

Table A-2.—*Stipa comata/Carex filifolia* habitat type.

Stand number	1	2	4	5	6	10	11	76	82	83	49	51	55	56	57	58	62	137
District	G	G	G	G	G	G	G	G	G	G	S	S	S	S	S	S	S	S
Location																		
Quartar section	NE	SW	SW	SW	NW	NE	SW	SE	NW	NE	NW	NE	SE	SE	NE	NW	NE	SW
Section	13	4	21	21	28	31	27	28	36	18	26	28	24	23	26	25	15	8
Township	21N	21N	22N	22N	22N	19N	22N	19N	18N	19N	2S	2S	21N	21N	21N	21N	22N	16N
Range	16E	14E	14E	14E	14E	13E	13E	13E	18E	18E	62E	62E	4E	4E	4E	4E	5E	4E
Topographic position																		
Slope (%)	2	--	--	2	4	13	8	4	13	12	5	3	--	2	1	3	2	--
Aspect (°)	243	--	--	258	128	98	345	263	38	298	127	77	--	62	357	347	297	--
Elevation (m)	--	--	--	--	--	--	--	--	--	--	1,006	1,036	1,030	1,036	1,036	1,033	994	1,167
								Coverage/Frequency										
Shrubs																		
Artemisia frigida	8/72	1/8	11/74	11/76	14/72	13/72	4/38	5/42	4/60	--	1/8	+/4	3/32	3/26	2/28	2/18	4/28	6/60
Gutierrezia sarothrae	--	--	1/2	--	+/2	--	--	--	--	--	--	--	+/2	--	--	--	--	--
Opuntia fragilis	*	--	--	--	--	+/2	*	+/2	+/2	+/2	+/2	*	--	--	--	--	--	--
Opuntia polyacantha	--	--	--	--	--	--	--	--	--	--	--	--	--	--	+/2	--	--	--
Rosa arkansana	--	--	--	--	--	--	--	1/8	--	--	--	--	--	1/12	--	--	*	--
Yucca glauca	--	--	*	--	*	*	--	--	--	--	--	--	--	--	--	--	--	--
Graminoids																		
Agropyron cristatum	1/28	*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Agropyron dasystachyum	--	--	20/50	13/58	25/88	--	--	--	--	--	--	--	--	--	--	--	--	--
Agropyron smithii	3/30	27/90	22/60	13/58	11/34	7/40	4/24	6/50	--	49/99	11/98	10/82	1/18	+/12	3/36	19/80	4/52	6/56
Agropyron spicatum	--	--	--	2/6	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--
Aristida longisata	+/8	+/2	--	--	--	2/18	*	4/28	+/4	6/28	3/30	2/18	+/4	3/12	1/26	+/2	1/14	+/2
Bouteloua curtipendula	--	--	--	--	--	--	--	2/10	--	--	--	--	--	--	--	--	--	--
Bouteloua gracilis	8/38	31/64	1/6	1/10	1/4	3/22	11/58	2/16	30/94	4/12	9/86	5/52	1/22	4/28	2/18	5/56	1/26	3/16
Bromus japonicus	--	20/74	--	--	--	--	--	--	--	+/6	+/4	+/10	--	--	--	--	+/4	+/8
Calamovilfa longifolia	+/2	--	--	--	--	--	--	1/10	2/4	+/2	--	--	--	--	--	--	--	--
Carex brevior	1/2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Carex eleocharis	--	5/74	12/64	3/34	6/48	11/64	*	1/20	+/2	+/2	3/58	+/8	+/12	*	*	1/14	1/40	+/2
Carex filifolia	8/30	32/99	76/99	87/99	84/99	73/99	67/99	71/99	55/99	59/99	63/99	32/99	41/99	23/99	29/99	50/90	59/99	64/99
Carex hellophila	--	--	--	--	--	--	--	--	5/30	+/4	+/2	+/8	1/4	*	*	18/34	+/8	--
Festuca octoflora	+/2	10/52	--	--	--	--	--	+/2	+/14	8/62	+/6	--	--	--	--	--	+/2	--
Koeleria pyramidata	6/30	*	--	--	1/8	+/4	9/42	1/12	23/98	5/52	2/10	7/68	5/58	*	1/24	3/32	8/62	6/54
Muhlenbergia cuspidata	--	--	--	1/6	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--
Panicum wilcoxianum	3/34	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Poa pratensis	--	2/20	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Poa sandbergii	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	+/2
Schedonnardus paniculatus	1/6	+/4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Stipa comata	84/99	85/99	48/96	74/99	75/99	73/99	72/99	77/99	71/99	74/99	88/99	81/99	78/99	77/99	81/99	77/99	84/99	78/99
Stipa viridula	--	2/8	3/22	+/4	1/12	--	--	--	--	9/44	--	--	--	--	--	+/6	--	--
Forbs																		
Achillea millefolium	--	1/4	--	--	--	--	--	--	--	--	--	*	*	--	+/4	--	--	--
Allium textile	*	--	*	+/2	--	--	+/6	*	+/6	--	--	--	--	--	--	--	--	--
Ambrosia psilostachya	--	+/4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antennaria rosea	*	*	--	--	--	--	--	--	--	--	--	+/2	--	+/2	--	--	--	--
Artemisia campestris	--	--	--	--	+/2	--	*	--	--	--	--	--	--	--	--	--	*	--
Artemisia dracunculus	2/34	7/40	4/28	4/50	2/18	+/4	4/38	3/28	--	--	--	--	3/12	2/28	*	*	+/4	1/10
Artemisia ludoviciana	--	+/2	--	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Asclepias pumila	--	--	--	--	--	--	--	+/6	--	--	--	--	--	--	--	--	--	--
Aster brachyactis	--	--	--	--	--	--	--	--	--	--	+/8	+/2	+/10	+/6	+/4	*	+/12	--
Aster ericoides	2/24	--	--	--	+/2	--	1/6	1/8	--	--	--	+/6	2/14	1/4	--	+/2	*	--
Astragalus adsurgens	1/2	--	*	*	1/2	--	1/4	--	--	--	--	--	--	--	--	--	--	--
Astragalus crassicarpus	--	--	--	+/8	--	--	*	--	--	+/2	--	--	--	--	--	--	--	--
Calylophus serrulatus	*	--	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--	--	--
Cerastium arvense	--	--	--	--	--	--	--	--	--	1/14	--	--	--	--	--	--	--	--
Chenopodium album	--	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--	--	--	--
Chenopodium dessicatum	--	+/14	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chrysopsis villosa	+/10	--	*	1/10	+/6	--	+/2	+/6	1/14	--	--	--	2/10	5/36	1/6	*	4/26	*
Cirsium undulatum	--	--	--	--	--	--	+/2	+/2	+/2	--	--	*	*	*	--	--	--	--
Collomia linearis	--	--	+/12	*	--	--	--	--	--	--	--	--	+/26	*	1/22	--	--	--
Comandra umbellata	--	+/6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	+/6	--
Coryphantha missouriensis	--	--	--	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--	--
Echinacea angustifolia	+/8	--	*	*	*	*	--	*	+/2	--	--	--	--	1/10	--	--	1/14	--
Erysimum asperum	--	--	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Gaura coccinea	+/6	+/2	+/4	+/2	+/4	1/12	+/2	+/6	+/2	+/4	--	1/12	3/34	1/12	+/6	+/18	--	*
Haplopappus spinulosus	--	--	--	--	--	--	--	--	+/4	--	--	--	--	--	--	--	--	--
Hedeoma hispida	+/2	1/30	--	--	--	--	+/12	+/24	+/2	1/24	1/24	--	--	--	--	--	--	+/2
Helianthus annuus	--	+/6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Helianthus rigidus	--	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--	--	--	--
Hymenopappus tilifolius	*	--	--	--	--	--	*	--	--	--	--	--	--	--	--	--	--	--
Hymenoxys acaulis	--	--	*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lactuca oblongifolia	--	--	--	--	--	--	--	--	--	+/4	--	--	--	--	--	--	--	--
Liatris punctata	+/4	*	*	2/16	1/12	+/6	--	+/2	+/4	--	+/2	+/2	--	+/4	--	--	+/6	--
Linum perenne	+/4	--	--	--	--	--	*	--	*	--	--	--	+/4	--	--	--	--	--
Linum rigidum	--	--	--	--	--	--	+/2	--	--	2/30	--	--	--	--	--	--	--	--
Lithospermum incisum	+/6	--	--	*	--	--	--	*	--	--	--	--	+/2	+/6	+/2	--	+/4	--
Lotus purshianus	1/20	+/6	--	--	--	--	--	+/6	1/56	1/12	--	--	2/34	5/66	5/74	22/99	+/6	--
Lygodesmia juncea	+/8	1/10	1/8	--	--	1/22	+/6	1/4	--	--	+/2	1/20	1/14	+/10	--	+/20	1/26	1/20
Melilotus officinalis	--	+/6	--	--	--	*	+/2	--	--	--	--	--	--	--	--	--	--	--
Orobanche fasciculata	--	--	*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Orthocarpus luteus	--	*	--	--	--	--	--	--	--	--	+/6	+/8	1/22	+/2	+/2	--	+/2	--
Oxytropis lambertii	2/18	--	--	--	--	--	*	--	1/10	--	--	+/2	+/4	+/2	+/4	--	*	--
Penstemon albidus	--	--	--	--	--	--	--	+/2	+/4	--	--	--	--	--	--	--	--	--
Penstemon angustifolius	--	--	--	--	--	--	+/6	--	--	--	--	--	--	--	--	--	--	--
Penstemon gracilis	+/4	--	--	--	--	--	--	--	--	--	--	+/4	--	--	--	--	--	--
Petalostemon purpureum	1/34	--	--	--	--	--	2/10	1/10	2/20	--	2/18	3/22	+/6	1/14	--	--	+/2	+/2
Phlox andicola	--	--	--	--	--	--	--	--	--	--	+/4	--	--	+/8	--	--	--	--
Phlox hoodii	--	--	--	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--	--
Plantago patagonica	+/2	1/24	--	--	--	--	+/8	+/4	+/2	+/4	--	--	+/2	--	--	--	--	--
Polygala alba	--	--	--	--	--	--	+/4	--	--	--	--	--	--	--	--	--	--	--
Polygala verticillata	--	--	--	--	--	--	--	--	--	--	1/50	--	--	--	1/32	--	--	--
Potentilla arguta	--	--	--	--	--	--	--	--	--	--	+/4	*	--	--	--	--	--	--
Potentilla pensylvanica	*	--	--	--	--	*	+/2	+/2	--	1/4	--	--	--	--	--	--	--	--
Psoralea argophylla	*	*	--	--	--	*	1/10	1/16	--	+/2	+/2	1/28	+/6	+/8	1/8	1/16	+/6	--
Psoralea esculenta	--	--	--	*	+/4	--	*	*	--	--	--	--	--	*	--	--	+/2	--
Psoralea tenuiflora	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	+/2
Ratibida columnifera	2/16	+/4	--	--	--	*	+/2	*	*	+/2	--	--	--	--	+/2	+/2	*	--
Selaginella densa	--	--	--	--	--	--	--	--	--	--	3/16	32/88	27/96	16/86	9/80	4/44	13/99	21/92
Solidago graminifolia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	+/2	--	--
Solidago missouriensis	--	--	--	--	--	--	--	--	4/20	--	+/6	+/2	+/4	--	--	--	--	--
Sphaeralcea coccinea	+/6	--	2/44	1/38	2/50	1/22	--	3/38	--	5/46	+/6	*	+/4	+/2	+/4	1/18	+/4	*
Taraxacum officinale	--	--	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--	--	--
Thermopsis rhombifolia	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	+/6	--
Tragopogon dubius	--	+/2	+/2	*	*	+/2	--	--	--	--	+/2	+/6	+/2	+/4	--	+/2	--	--
Vicia americana	--	+/2	--	--	1/6	--	--	--	--	--	--	--	--	--	--	--	--	--
Bare ground	18/99	1/10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Species in microplots	31	28	16	18	22	17	26	31	25	25	26	24	29	27	22	19	27	16
Coverage of shrubs	8	1	12	11	14	13	4	6	4	0	1	0	3	4	2	2	4	6
Coverage of graminoids	114	214	182	194	204	169	163	165	186	214	179	137	127	107	117	173	158	157
Coverage of forbs	11	11	7	8	7	3	9	10	9	11	7	38	41	32	18	28	19	23
Total coverage	133	226	201	213	225	185	176	181	199	225	187	175	171	143	137	203	181	186

Table A-3.—*Stipa comata/Carex heliophila* habitat type.

Stand number	63	112	113	116	118	29	38	40	102	108
District	S	S	S	S	S	A	A	A	A	A
Location										
Quarter section	SW	SW	SW	SE	NW	SE	SE	NE	SW	NW
Section	25	3	33	28	25	1	18	17	14	3
Township	1N	2S	1S	1N	1N	5S	6S	6S	3S	6S
Range	58E	61E	61E	58E	58E	44E	45E	45E	45E	44E
Topographic position										
Slope (%)	2	2	4	8	--	3	2	2	8	5
Aspect (°)	327	317	217	222	--	220	110	255	175	180
Elevation (m)	1,219	1,219	1,225	1,244	1,207	1,253	1,253	1,244	981	1,247
						Coverage/Frequency				
Shrubs										
Artemisia cana	--	--	--	--	--	+/2	+/4	--	--	--
Artemisia frigida	1/12	1/16	1/12	1/20	+/8	*	5/56	2/18	--	2/24
Gutierrezia sarothrae	--	--	--	--	--	+/2	3/22	1/12	--	+/4
Opuntia fragilis	+/2	--	--	--	--	--	--	--	--	--
Rosa arkansana	+/2	*	+/4	1/32	3/50	1/14	+/8	+/2	--	--
Symphoricarpos occidentalis	--	*	--	--	--	--	--	--	--	--
Graminoids										
Agropyron smithii	4/72	8/68	7/82	1/22	2/44	25/70	2/20	1/18	1/36	2/44
Agropyron spicatum	--	--	--	--	--	--	10/58	9/32	--	--
Aristida longiseta	--	--	--	--	--	--	+/2	1/6	1/8	--
Bouteloua curtipendula	--	--	--	--	--	1/4	--	+/2	+/2	--
Bouteloua gracilis	18/96	*	--	+/2	1/14	--	1/12	6/28	7/34	+/2
Bromus japonicus	--	--	--	--	--	23/76	+/10	3/50	2/44	30/99
Calamovilfa longifolia	--	--	--	--	--	+/4	--	--	--	--
Carex eleocharis	1/14	--	--	+/4	--	--	--	+/4	--	--
Carex filifolia	3/14	--	1/4	2/6	+/2	--	--	--	--	--
Carex heliophila	67/99	68/99	70/99	39/99	61/99	50/99	23/99	26/99	26/72	52/99
Festuca idahoensis	--	--	--	--	--	--	--	1/4	--	2/4
Festuca octoflora	+/2	+/2	--	--	--	--	--	--	+/18	--
Koeleria pyramidata	1/18	5/58	6/62	4/82	3/58	2/28	8/76	10/84	6/66	5/36
Muhlenbergia cuspidata	--	--	--	--	--	--	1/2	3/16	--	--
Poa canbyi	--	2/12	+/6	--	--	7/38	--	--	--	6/56
Poa pratensis	--	9/32	--	--	+/2	--	1/6	--	--	--
Poa sandbergii	--	--	--	+/4	--	--	--	--	--	--
Stipa comata	57/99	57/99	81/99	82/99	83/99	48/90	41/99	40/96	74/99	50/99
Stipa viridula	1/8	27/82	1/4	--	+/2	16/48	1/8	3/36	1/6	4/32
Forbs										
Achillea millefolium	+/2	+/4	+/2	--	+/2	*	+/16	+/4	--	1/6
Ambrosia psilostachya	--	--	--	--	--	2/24	--	+/10	--	--
Antennaria rosea	+/2	+/2	+/2	2/16	1/2	3/16	1/8	+/6	+/2	*
Artemisia campestris	3/18	--	--	--	--	--	--	--	--	--
Artemisia dracunculus	+/4	--	+/2	--	+/2	*	1/4	--	4/34	*
Artemisia ludoviciana	6/48	6/66	6/48	1/84	11/92	2/38	1/30	3/56	13/58	3/36
Asclepias verticillata	--	--	--	--	--	--	--	--	+/8	--
Asclepias viridiflora	--	--	--	--	--	*	--	--	--	--
Aster brachyactis	+/20	--	--	--	--	--	--	--	--	--
Aster ericoides	2/20	+/10	*	*	4/60	7/60	+/10	2/30	1/6	+/8
Calylophus serrulatus	*	--	--	--	--	--	--	--	--	--
Cerastium arvense	--	1/18	--	1/6	--	--	--	--	--	--
Chrysopsis villosa	2/18	*	+/2	2/30	3/24	1/4	1/14	--	+/4	--
Cirsium undulatum	*	--	--	--	--	--	--	--	--	--
Collomia linearis	+/16	--	--	--	--	--	--	--	--	+/20
Coryphantha vivipara	--	--	--	--	--	--	--	--	--	+/2
Echinacea angustifolia	1/26	+/2	+/2	--	+/10	--	1/14	+/2	+/2	+/4
Erysimum asperum	--	--	--	--	--	--	--	+/2	--	--
Gaura coccinea	+/2	+/20	+/6	--	+/2	+/12	+/6	+/2	+/4	+/8
Geum triflorum	--	--	--	--	--	*	--	--	--	--
Hedeoma hispida	--	--	--	+/2	--	--	--	--	--	--
Helianthus rigidus	--	+/8	--	--	+/2	--	--	--	--	--
Kuhnia eupatorioides	--	--	--	--	--	--	--	+/2	--	--
Lactuca oblongifolia	+/8	--	+/2	--	--	--	--	--	--	--
Liatris punctata	1/6	*	*	+/6	1/14	--	*	--	--	+/2
Linum rigidum	--	--	--	--	--	--	*	--	--	--

Lithospermum incisum	--	--	+ /2	--	--	--	--	+ /2	--	--
Lupinus argenteus	--	1/6	--	--	--	--	--	--	--	*
Lygodesmia juncea	+ /2	--	+ /2	--	--	+ /2	--	--	+ /4	+ /10
Orthocarpus luteus	+ /4	*	+ /6	1/28	1/26	1/16	--	*	--	+ /18
Oxytropis lambertii	+ /2	--	+ /2	+ /2	1/8	--	--	--	--	--
Penstemon angustifolius	--	--	--	--	--	--	+ /6	--	--	--
Penstemon gracilis	--	--	+ /2	--	1/8	--	*	--	--	--
Petalostemon purpureum	+ /4	--	+ /2	+ /6	+ /6	+ /2	+ /4	+ /12	--	--
Phlox andicola	--	--	--	--	--	--	1/18	1/16	--	+ /6
Phlox hoodii	--	--	--	--	+ /6	--	--	--	--	--
Plantago patagonica	--	--	--	--	--	--	--	--	*	*
Potentilla arguta	*	--	--	--	--	--	--	--	--	--
Psoralea argophylla	+ /4	+ /8	+ /4	+ /4	*	+ /10	1/38	+ /12	+ /6	*
Psoralea esculenta	--	--	--	--	--	--	+ /2	--	+ /4	--
Ratibida columnifera	--	--	*	*	--	1/16	+ /8	+ /2	1/22	+ /8
Selaginella densa	1/8	3/26	41/88	68/99	49/96	--	--	--	3/22	--
Solidago rigida	--	+ /6	+ /4	--	--	--	--	--	+ /2	--
Sphaeralcea coccinea	+ /10	--	+ /2	--	+ /4	--	+ /2	+ /8	--	+ /12
Tragopogon dubius	--	1/12	*	--	--	+ /2	--	--	*	*
Vicia americana	+ /4	--	--	--	--	--	--	--	--	--
Zigadenus venenosus	--	+ /4	--	--	--	--	--	--	--	--
Species in microplots	33	23	27	21	27	24	30	31	24	24
Coverage of shrubs	1	1	1	2	3	1	8	3	0	2
Coverage of graminoids	152	176	166	128	150	172	88	103	118	151
Coverage of forbs	16	12	47	84	72	17	7	6	22	4
Total coverage	169	189	214	214	225	190	103	112	140	157

Table A-4.—*Festuca idahoensis/Carex heliophila* habitat type.

Stand number	**26**	**41**	**42**	**43**	**86**	**106**	**107**	**109**
District	A	A	A	A	A	A	A	A
Location								
Quarter section	SE	NE	SW	SW	SE	SE	NE	SW
Section	34	17	9	14	36	5	3	15
Township	6S	6S	6S	6S	6S	6S	6S	6S
Range	47E	45E	45E	44E	43E	44E	44E	44E
Topographic position								
Slope (%)	5	5	5	15	12	7	5	--
Aspect (°)	180	5	205	20	355	245	125	--
Elevation (m)	1,262	1,237	1,271	1,250	1,183	1,244	1,247	1,256
			Coverage/Frequency					
Shrubs								
Artemisia cana	1/4	--	--	--	--	--	--	--
Artemisia frigida	--	1/8	+ /4	1/14	+ /6	+ /4	*	+ /2
Gutierrezia sarothrae	--	+ /10	+ /4	+ /2	+ /2	1/8	*	--
Rhus aromatica	--	--	--	--	*	--	--	--
Rosa arkansana	2/12	--	2/16	1/38	--	+ /6	+ /12	+ /18
Symphoricarpos occidentalis	--	--	--	--	1/12	--	--	--
Graminoids								
Agropyron smithii	6/42	1/12	9/72	2/70	+ /10	+ /12	2/24	2/22
Agropyron spicatum	--	+ /4	--	--	+ /2	+ /2	+ /2	--
Andropogon gerardi	--	1/8	1/2	--	--	--	--	--
Aristida longiseta	--	--	1/16	1/18	+ /4	--	*	--
Bouteloua curtipendula	--	+ /4	--	--	1/10	--	1/10	--
Bouteloua gracilis	6/28	--	3/24	--	--	3/8	1/6	2/28
Bromus japonicus	+ /4	--	1/20	+ /2	1/10	--	+ /2	+ /12
Calamovilfa longifolia	7/38	--	--	--	--	--	--	--
Carex heliophila	39/99	27/99	17/96	56/99	34/99	13/84	9/92	10/92
Festuca idahoensis	67/98	65/98	50/99	87/99	83/99	81/99	82/99	87/99
Festuca octoflora	+ /2	--	--	--	--	--	--	--
Koeleria pyramidata	12/66	3/28	3/38	+ /14	8/64	3/44	1/38	2/34
Muhlenbergia cuspidata	--	1/12	--	--	--	--	--	--

Poa canbyi	--	--	--	--	4/34	--	--	--
Poa sandbergii	6/28	--	--	--	--	--	*	--
Stipa comata	11/54	1/6	6/44	1/6	*	+/6	1/20	1/16
Stipa viridula	+/2	1/22	+/2	1/8	+/2	--	--	+/2
Forbs								
Achillea millefolium	--	+/16	*	+/8	*	*	--	*
Ambrosia psilostachya	1/8	--	1/12	--	+/10	--	+/10	--
Antennaria rosea	--	+/2	+/2	--	1/4	1/14	+/2	+/2
Artemisia dracunculus	--	--	--	*	--	*	1/8	--
Artemisia ludoviciana	6/48	3/46	+/10	7/64	2/28	+/2	1/26	3/60
Aster ericoides	1/4	4/50	8/64	7/50	1/4	1/10	+/4	1/10
Astragalus adsurgens	--	--	--	--	--	--	*	--
Cerastium arvense	--	--	--	--	+/8	--	--	--
Chrysopsis villosa	--	--	+/2	+/6	--	--	*	--
Cirsium undulatum	+/2	+/2	+/6	+/4	--	--	--	--
Echinacea angustifolia	--	1/22	1/12	+/4	2/26	*	+/6	*
Erysimum asperum	--	--	+/4	--	--	--	--	--
Gaura coccinea	+/6	+/4	--	+/10	--	+/2	+/2	--
Geum triflorum	--	4/30	--	+/2	*	--	--	--
Kuhnia eupatorioides	--	--	*	--	--	--	--	--
Liatris punctata	--	*	--	+/2	--	+/2	*	--
Linum perenne	--	*	--	--	--	--	--	--
Lithospermum incisum	--	--	--	--	--	+/2	--	+/2
Lupinus argenteus	*	+/2	+/2	2/18	1/4	*	1/8	*
Lygodesmia juncea	*	--	--	--	--	--	--	1/6
Orthocarpus luteus	+/8	+/4	--	+/10	--	--	--	--
Oxytropis sericea	--	+/2	--	--	--	--	--	--
Petalostemon purpureum	--	2/30	4/40	1/16	--	--	*	--
Phlox alyssifolia	--	+/4	--	--	--	--	--	--
Phlox andicola	--	2/22	+/2	--	--	+/2	+/10	--
Phlox hoodii	--	--	--	--	1/18	--	--	--
Potentilla arguta	--	--	--	+/2	--	--	--	--
Psoralea argophylla	--	+/8	--	1/18	1/14	--	--	+/2
Psoralea esculenta	--	--	+/18	--	--	--	*	+/2
Ratibida columnifera	*	1/26	*	+/10	*	--	*	--
Solidago graminifolia	--	--	--	1/16	--	--	--	--
Solidago missouriensis	1/14	--	+/4	+/6	--	--	--	--
Solidago rigida	+/2	--	--	--	--	--	--	+/4
Sphaeralcea coccinea	--	--	--	*	--	1/22	+/20	1/40
Tragopogon dubius	--	--	+/2	+/6	--	--	--	*
Vicia americana	--	--	--	--	+/4	--	--	--
Zigadenus venenosus	--	--	--	+/8	--	--	*	--
Bare ground	--	--	--	--	--	20/99	17/98	11/99
Species in microplots	21	28	27	30	23	18	20	19
Coverage of shrubs	3	1	2	2	1	1	0	0
Coverage of graminoids	154	100	91	148	131	100	97	104
Coverage of forbs	9	17	14	19	9	3	3	6
Total coverage	166	118	107	169	141	104	100	110

Table A-5.—*Agropyron smithii/Carex filifolia* habitat type.

Stand number	3	8	16	65	73	81	52	61	136	138
District	G	G	G	G	G	G	S	S	S	S
Location										
Quarter section	SW	SE	NW	SW	SW	NE	NE	NE	NW	SE
Section	3	14	3	5	5	26	28	26	2	8
Township	21N	20N	19N	20N	19N	18N	2S	21N	21N	16N
Range	14E	15E	13E	16E	13E	18E	62E	4E	5E	4E
Topographic position										
Slope (%)	--	8	--	6	2	--	7	--	2	--
Aspect (°)	--	168	--	170	13	--	177	--	307	--
Elevation (m)	--	--	--	--	--	--	1,033	1,093	1,018	1,164

	Coverage/Frequency									
Shrubs										
Artemisia cana	--	3/8	--	--	--	--	--	--	--	--
Artemisia frigida	--	--	--	4/28	+/4	--	+/6	--	--	5/70
Opuntia fragilis	--	--	+/4	+/2	--	--	+/4	--	--	--
Opuntia polyacantha	--	+/2	--	--	--	--	--	--	--	+/4
Symphoricarpos occidentalis	--	1/6	--	--	--	--	--	--	--	--
Graminoids										
Agropyron smithii	88/99	92/99	77/99	66/99	98/99	90/99	76/99	96/99	91/99	79/99
Alopecurus carolinianus	12/70	--	--	--	--	12/84	--	--	--	--
Andropogon scoparius	--	+/2	--	--	--	--	--	--	--	--
Aristida longiseta	--	--	+/2	1/4	--	--	+/2	--	--	+/2
Bouteloua curtipendula	--	*	2/8	--	--	--	--	--	--	--
Bouteloua gracilis	--	5/16	15/32	8/62	--	--	12/86	--	--	1/4
Bromus japonicus	--	--	*	--	2/38	--	+/2	--	--	23/99
Buchloe dactyloides	--	--	31/48	4/12	--	+/2	--	--	--	--
Calamovilfa longifolia	--	--	--	1/4	--	--	--	--	--	--
Carex eleocharis	--	3/16	13/74	1/24	37/98	--	--	--	--	*
Carex filifolia	--	70/99	*	48/99	11/46	--	--	--	--	63/99
Carex heliophila	--	--	--	--	--	--	4/24	+/6	--	--
Distichlis spicata	--	--	--	--	--	--	2/36	--	--	--
Eleocharis acicularis	--	--	--	--	--	--	--	38/98	28/99	--
Festuca octoflora	--	--	2/34	+/4	2/32	--	--	--	--	--
Hordeum jubatum	--	--	--	--	--	--	--	--	5/32	--
Juncus interior	--	--	--	--	--	--	+/6	--	--	--
Koeleria pyramidata	--	+/6	*	5/40	--	--	+/2	--	--	1/22
Poa pratensis	--	1/8	--	--	+/4	--	+/4	--	--	4/12
Poa sandbergii	--	--	--	--	--	--	--	--	--	4/32
Schedonnardus paniculatus	--	--	+/2	--	--	--	--	--	--	--
Stipa comata	--	4/38	2/10	5/38	1/4	--	--	--	--	6/38
Stipa viridula	--	12/48	+/2	13/64	+/4	--	--	--	--	8/24
Forbs										
Achillea millefolium	--	--	--	--	+/2	--	--	--	--	+/8
Allium textile	--	--	*	+/4	--	--	--	--	--	--
Anemone patens	--	+/2	--	--	--	--	--	--	--	--
Antennaria rosea	--	--	--	*	--	--	--	--	--	--
Artemisia dracunculus	--	--	*	+/2	--	--	--	--	--	*
Aster brachyactis	--	--	--	+/8	--	--	+/6	--	--	--
Astragalus crassicarpus	--	--	--	+/2	--	--	--	--	--	--
Cerastium brachypodum	--	--	--	+/10	--	--	--	--	--	--
Collomia linearis	--	--	--	+/4	--	--	--	--	--	--
Coryphantha missouriensis	--	--	--	--	--	--	*	--	--	--
Echinacea angustifolia	--	--	--	*	--	--	--	--	--	--
Gaura coccinea	--	*	--	*	--	--	--	--	--	+/2
Grindelia squarrosa	*	--	*	--	--	--	--	--	--	--
Hedeoma hispida	--	--	--	1/46	+/2	--	+/8	--	--	--
Helianthus rigidus	--	+/2	--	--	--	--	--	--	--	--
Lithospermum incisum	--	--	--	--	--	--	--	--	--	+/2
Lotus purshianus	--	--	+/6	3/64	--	--	--	--	--	--
Lygodesmia juncea	--	+/2	--	--	--	--	--	--	--	+/6
Melilotus officinalis	--	--	--	1/2	--	--	--	--	--	--
Orthocarpus luteus	--	--	--	--	--	--	*	--	--	--
Penstemon gracilis	--	--	--	1/10	--	--	--	--	--	--
Plagiobothrys scouleri	--	--	--	--	--	38/84	--	--	--	--
Plantago patagonica	--	--	4/52	+/8	--	--	--	--	--	--
Polygala alba	--	--	--	+/2	--	--	--	--	--	--
Polygala verticillata	--	--	--	--	--	--	1/16	--	--	--
Polygonum ramosissimum	9/48	--	2/12	--	--	4/48	--	--	--	--
Potentilla arguta	--	--	--	--	--	--	+/2	--	--	--
Potentilla glandulosa	--	--	--	--	--	--	--	--	--	+/2
Psoralea argophylla	--	--	--	1/4	--	--	--	--	--	+/10
Psoralea esculenta	--	+/2	--	*	--	--	--	--	--	--
Ratibida columnifera	--	--	--	1/16	--	--	--	--	--	--
Selaginella densa	--	--	--	--	--	--	55/88	--	--	13/86
Sphaeralcea coccinea	--	1/10	1/18	6/64	--	--	--	--	--	--
Tragopogon dubius	--	*	--	+/2	*	--	--	--	--	--
Vicia americana	--	--	+/8	--	--	--	--	--	--	--
Species in microplots	3	17	16	29	11	5	16	3	3	19
Coverage of shrubs	0	4	0	4	0	0	0	0	0	5
Coverage of graminoids	100	187	142	152	151	102	94	134	124	189
Coverage of forbs	9	1	7	14	0	42	56	0	0	13
Total coverage	109	192	149	170	151	144	150	134	124	207

Table A-6.—*Andropogon scoparius/Carex filifolia* habitat type.

Stand number	12	13	14	17	64	67	71	77	122	127	139	141	19	20	21	22
District	G	G	G	G	G	G	G	G	S	S	S	S	A	A	A	A
Location																
Quarter section	SW	SE	SE	NE	SW	SE	NE	SE	NE	NE	NE	SW	NE	NE	NW	NW
Section	27	14	14	4	18	6	8	31	11	26	19	19	21	21	19	19
Township	22N	20N	20N	19N	20N	20N	23N	19N	2S	19N	19N	19N	4S	4S	6S	6S
Range	13E	15E	15E	13E	16E	16E	11E	13E	60E	7E	8E	8E	45E	45E	46E	46E
Topographic position																
Slopa (%)	18	18	8	15	8	12	5	17	30	30	25	20	35	36	15	12
Aspect (°)	308	348	308	333	223	293	193	38	37	337	22	282	45	320	355	5
Elevation (*m*)	--	--	--	--	--	--	--	--	1,055	1,061	1,061	1,079	969	969	1,012	1,012
								Coverage/Frequency								
Shrubs																
Artemisia cana	--	•	--	--	--	--	--	--	--	+/2	--	--	--	--	--	--
Artemisia frigida	+/6	+/8	1/16	+/10	+/10	+/8	+/4	1/8	+/2	•	+/4	•	+/4	2/20	1/12	1/8
Artemisia tridantata	--	--	--	--	--	--	--	--	--	--	--	--	+/2	--	--	--
Gutierrezia sarothrae	•	--	+/4	--	+/2	--	--	--	--	--	--	--	+/2	1/16	1/16	+/6
Opuntia fragilis	--	--	•	--	--	--	--	--	--	--	--	--	--	--	--	--
Opuntia polyacantha	--	--	--	--	--	--	--	--	--	--	--	--	+/2	--	•	--
Rhus aromatica	--	--	--	--	--	--	--	--	•	3/8	•	--	•	+/2	--	--
Rosa arkansana	+/8	1/22	1/8	•	--	+/8	+/2	+/8	1/46	2/18	+/2	+/8	+/6	--	--	•
Shepherdia argentea	--	+/4	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Symphoricarpos occidentalis	--	--	--	+/2	--	--	--	+/2	--	2/12	--	--	--	--	--	--
Toxicodendron rydbergii	--	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Yucca glauca	--	--	--	•	--	•	--	--	+/2	--	•	--	+/2	--	--	+/4
Graminoids																
Agropyron caninum	--	+/4	--	--	--	--	1/22	--	--	--	--	--	--	--	--	--
Agropyron dasystachyum	--	--	--	--	--	--	--	--	--	--	+/2	--	--	--	--	--
Agropyron smithii	--	--	--	1/10	+/4	--	--	+/10	--	--	--	--	--	--	--	--
Agropyron spicatum	--	--	--	--	--	--	--	--	--	--	--	--	9/56	6/18	+/4	3/12
Andropogon scoparius	78/99	67/99	58/99	69/99	79/99	86/99	88/99	86/99	84/99	97/99	91/99	97/99	55/98	41/90	70/99	68/99
Aristida longiseta	--	--	--	--	--	--	--	--	--	--	--	--	1/4	1/4	--	--
Bouteloua curtipandula	--	9/64	28/98	2/4	2/38	5/18	--	•	--	--	--	--	11/68	17/84	6/40	5/48
Bouteloua gracilis	--	--	+/2	--	2/16	1/6	--	--	--	--	+/2	--	--	--	--	--
Bromus japonicus	--	--	--	--	--	--	--	--	--	--	--	--	--	+/2	+/4	+/4
Calamovilfa longifolia	4/22	6/32	3/18	12/54	1/6	--	+/4	1/22	--	--	1/12	•	--	--	--	--
Carex elaocharis	--	--	+/6	--	--	--	--	+/2	--	--	--	--	--	--	--	--
Carex filifolia	52/99	39/99	40/99	47/99	37/99	49/99	17/78	22/88	22/92	21/84	24/86	12/70	1/10	27/96	18/82	21/86
Carex hellophila	--	--	--	--	--	--	--	9/46	4/36	--	5/28	6/60	6/34	1/24	2/18	+/4
Festuca idahoensis	--	--	--	--	--	--	--	--	--	--	--	--	--	1/6	--	--
Festuca octoflora	--	--	--	--	•	+/4	--	--	--	--	--	--	--	--	--	--
Helictotrichon hookeri	--	--	--	--	--	--	--	--	--	--	+/2	--	--	--	--	--
Koeleria pyramidata	2/32	4/44	2/28	1/18	1/34	1/18	1/12	2/18	3/52	--	+/2	•	2/32	2/34	+/6	1/8
Muhlenbergia cuspidata	--	--	--	--	--	--	--	--	--	--	+/4	--	--	1/4	--	--
Poa canbyi	--	--	--	--	--	--	--	--	+/6	--	--	--	--	--	--	--
Poa pratensis	--	+/2	--	1/4	--	+/2	--	•	--	•	+/2	--	--	--	--	--
Poa sandbergii	--	--	--	--	--	--	--	--	--	--	•	--	--	--	--	--
Stipa comata	+/6	1/10	+/2	--	•	--	--	--	•	--	+/2	--	+/2	+/2	+/4	+/2
Stipa viridula	--	+/6	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Forbs																
Achillea millefolium	--	--	--	--	--	--	•	--	--	+/6	+/10	+/2	1/26	--	--	--
Agoseris glauca	--	--	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--
Allium textile	+/2	+/6	--	--	•	--	--	+/6	--	--	--	--	--	+/2	--	--
Anemone canadensis	--	--	--	--	--	--	--	+/8	--	+/6	--	--	--	--	--	--
Anemone cylindrica	1/6	--	--	+/2	--	--	--	--	--	--	--	+/4	--	--	--	--
Anemone patens	5/52	6/70	--	--	--	--	--	--	--	+/6	--	1/32	--	--	--	--
Antennaria rosea	--	--	+/6	+/6	--	--	+/2	--	+/6	•	--	--	+/12	+/12	+/2	+/4
Arabis hirsuta	--	--	--	--	--	--	1/42	+/8	--	--	--	--	--	--	--	--
Artemisia campestris	1/16	--	--	--	•	+/10	--	+/6	+/2	--	--	--	--	--	--	--
Artemisia dracunculus	•	1/18	+/10	+/6	+/4	1/10	--	•	+/2	+/2	•	•	--	--	--	--
Artemisia ludoviciana	--	--	--	--	--	--	+/2	--	•	+/4	+/2	--	+/10	--	--	+/2
Asclepias pumila	--	--	--	--	--	--	--	--	--	--	--	--	+/6	--	--	--
Aster brachyactis	--	--	--	--	--	--	•	--	--	--	--	--	--	--	--	--
Aster ericoides	--	--	1/12	+/8	1/24	+/10	+/6	+/10	•	+/4	1/32	+/4	1/20	1/22	1/18	+/4
Astragalus adsurgens	--	+/2	--	+/4	--	--	6/32	•	--	--	--	--	--	--	--	--
Astragalus flexuosus	•	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Astragalus gilviflorus	--	+/4	--	+/2	+/4	•	+/2	+/4	--	+/2	--	--	--	+/4	--	--
Astragalus gracilis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2/26	+/4
Astragalus spatulatus	--	--	--	--	--	--	--	--	--	--	--	--	--	+/2	--	--
Calyiophus sarrulatus	+/2	2/22	--	+/2	+/6	--	--	+/2	--	•	--	--	+/4	+/2	--	--
Campanula rotundifolia	--	--	--	--	--	--	--	--	--	--	+/8	+/10	+/6	2/22	--	--
Castilleja sessiliflora	--	--	--	+/6	--	--	1/4	--	--	--	--	--	+/2	+/2	--	--
Cerastium arvensa	--	--	--	--	--	--	--	--	1/38	--	--	+/2	--	--	--	--
Carastium nutans	--	--	--	--	--	--	+/8	--	--	--	--	--	--	--	--	--
Chrysopsis villosa	2/20	+/6	•	--	--	1/6	•	•	+/10	--	+/4	•	+/4	•	--	--
Cirsium undulatum	•	--	--	•	--	--	+/2	+/10	--	--	--	--	--	--	•	--
Comandra umbellata	2/20	3/56	--	--	+/2	--	1/18	•	1/34	•	+/10	+/10	--	--	--	--
Coryphantha missouriensis	--	--	•	--	--	--	--	--	--	--	--	--	--	--	--	--
Echinacea angustifolia	1/26	8/60	2/34	1/22	+/6	2/50	1/20	+/18	1/48	--	--	--	2/50	8/86	2/36	3/34
Erysimum cheiranthoides	--	--	--	--	--	--	•	+/2	--	--	--	--	--	--	--	--
Galium boreale	--	--	--	--	--	--	--	--	--	--	2/36	--	--	--	--	--
Gaura coccinea	--	--	•	1/6	+/2	+/6	+/2	•	--	+/2	--	--	--	--	--	--
Geum triflorum	--	--	--	--	--	--	--	--	--	+/2	•	--	--	--	•	--
Glycyrrhiza lepidota	--	3/34	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hedeoma hispida	--	--	--	--	+/2	+/4	--	--	--	--	--	--	--	--	--	--
Helianthus rigidus	•	2/32	--	1/20	--	•	1/8	4/42	•	+/2	3/42	1/14	--	--	--	--
Hymenopappus filifolius	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hymenoxys acaulis	•	+/2	+/2	+/2	--	+/2	--	--	--	--	--	--	--	--	--	--
Lactuca oblongifolia	--	--	--	1/26	--	+/10	+/2	+/6	--	--	--	--	--	--	--	--
Liatrus punctata	+/10	+/2	+/4	--	+/2	+/6	--	--	1/32	--	--	--	+/2	1/12	+/2	+/4
Linum perenne	--	+/2	--	--	--	--	--	--	--	--	+/2	--	+/2	+/2	--	--
Linum rigidum	--	--	+/6	+/2	+/2	•	+/2	--	--	--	--	+/2	+/2	+/2	--	+/2
Lithosparmum incisum	--	--	--	1/4	--	--	--	--	--	--	--	--	--	--	--	--
Lotus purshianus	--	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--	--
Lygodesmia juncea	--	--	1/14	•	1/28	+/8	+/4	+/2	+/4	--	--	--	--	--	+/10	+/4
Melilotus officinalis	•	+/2	--	--	--	•	--	--	--	--	--	--	--	--	+/2	+/2
Monarda fistulosa	--	--	--	--	--	--	--	--	--	1/26	--	--	--	--	--	--
Mosses and lichens	1/16	--	--	--	--	11/99	--	--	--	--	--	--	--	--	--	--
Orthocarpus luteus	--	--	+/2	--	--	--	--	--	•	--	--	--	--	•	2/14	--
Oxytropis lambertii	2/14	1/8	1/18	+/8	+/6	+/6	+/2	--	+/2	--	--	--	2/20	+/8	+/4	2/16
Oxytropis sericea	--	--	--	--	+/2	--	--	--	--	--	--	--	--	--	--	--
Penstemon gracilis	--	--	--	•	--	--	--	--	--	--	--	--	--	--	--	--
Petalostemon candidum	--	1/8	--	+/2	--	--	--	--	--	--	--	--	--	--	--	--
Petalostemon occidantale	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	•
Petalostemon purpureum	5/44	3/46	+/6	+/2	1/38	1/24	•	+/2	4/54	--	1/12	1/26	+/4	1/12	+/6	+/2
Phlox alyssifolia	--	--	--	--	--	--	+/6	--	--	--	--	--	--	--	--	--
Phlox hoodii	--	--	--	--	+/18	+/8	--	+/4	--	--	--	--	+/8	1/18	•	--
Polygala alba	+/2	--	--	+/2	+/2	+/8	+/2	--	--	--	--	--	+/4	+/2	+/2	--
Potentilla arguta	--	+/6	--	--	--	--	--	--	--	+/2	--	--	--	--	--	--
Potentilla pansylvanica	--	--	--	•	--	--	--	--	--	--	--	--	--	--	--	--
Psoralea argophylla	--	--	+/8	+/2	•	1/18	3/52	1/26	--	--	+/2	--	+/10	+/2	1/22	1/18
Psoralaa asculenta	•	--	•	--	+/2	+/2	+/2	•	•	--	+/4	1/4	•	+/2	+/2	--
Psoralea tenuiflora	--	--	--	--	--	--	--	--	--	--	--	•	--	--	--	--
Ratibida columnitara	+/2	--	--	•	--	•	--	•	--	--	--	--	+/4	--	--	--
Salaginella densa	--	--	--	--	--	--	+/10	--	3/32	--	+/2	--	--	--	--	--
Senacio canus	--	--	--	--	--	--	--	--	--	--	+/2	--	--	•	--	--
Sanacio plattansis	•	--	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--
Solidago missouriensis	--	--	+/2	--	+/10	+/2	--	--	--	--	2/4	--	1/18	+/2	--	--
Solidago nemoralis	•	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Solidago rigida	--	4/44	+/4	1/10	--	--	--	+/8	+/2	+/2	1/12	+/6	+/4	--	--	--
Sphaeralcea coccinea	--	--	+/2	--	•	+/2	--	--	--	--	--	--	--	--	--	--
Taraxacum officinale	--	--	--	--	--	--	+/4	--	--	--	--	--	--	--	--	--
Thermopsis rhombifolia	--	--	--	--	--	--	--	--	--	--	1/12	--	--	•	--	--
Thlaspi arvanse	--	--	--	--	--	--	--	--	--	--	--	--	+/2	--	--	--
Tragopogon dubius	•	--	--	--	--	--	--	--	--	--	--	--	•	--	•	+/4
Vicia americana	--	--	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--
Species in microplots	22	33	28	30	27	30	31	27	21	19	30	16	36	33	23	24
Coverage of shrubs	0	1	2	0	0	0	0	1	1	7	0	0	0	3	2	1
Coverage of graminoids	136	126	131	133	122	142	107	120	113	118	121	115	85	97	96	98
Coverage of forbs	20	32	5	6	3	17	14	5	11	1	11	4	7	14	8	6
Total coverage	156	159	138	139	125	159	121	126	125	126	132	119	92	114	106	105

Table A-7.—*Calamovilfa longifolia/Carex heliophila* habitat type.

Stand number	148	149	150	151
District	G	G	G	G
Location				
Quarter section	SW	NW	NE	NW
Section	17	35	22	22
Township	22N	23N	20N	20N
Range	11E	12E	15E	15E
Topographic position				
Slope (%)	10	15	15	5
Aspect (°)	158	128	348	168
Elevation (m)	--	--	--	--
		Coverage/Frequency		
Shrubs				
Artemisia frigida	--	+/2	+/2	1/4
Graminoids				
Agropyron smithii	1/24	*	--	1/12
Andropogon gerardi	*	--	--	--
Aristida longiseta	--	1/8	--	--
Bouteloua gracilis	+/6	4/42	+/2	1/4
Bromus japonicus	--	--	--	1/18
Calamovilfa longifolia	93/99	94/99	95/99	96/99
Carex filifolia	1/2	1/8	--	--
Carex heliophila	90/99	91/99	91/99	64/98
Festuca octoflora	--	--	+/2	+/8
Koeleria pyramidata	+/6	+/12	+/6	+/2
Poa pratensis	--	+/6	2/4	+/2
Stipa comata	+/2	--	--	--
Stipa viridula	*	--	--	--
Forbs				
Ambrosia psilostachya	--	--	2/12	4/40
Artemisia dracunculus	--	1/6	*	--
Artemisia ludoviciana	6/46	+/16	*	2/16
Aster ericoides	--	--	--	*
Chenopodium album	--	--	+/6	+/4
Conyza canadensis	--	+/4	*	+/8
Gaura coccinea	--	+/2	--	--
Glycyrrhiza lepidota	+/4	--	--	--
Hedeoma hispida	--	--	+/4	+/8
Lactuca oblongifolia	1/26	--	--	--
Liatris punctata	--	--	+/2	--
Lithospermum incisum	--	--	+/2	--
Lotus purshianus	--	+/8	--	--
Lygodesmia juncea	+/4	--	2/20	+/2
Psoralea argophylla	2/24	2/56	*	+/2
Ratibida columnifera	--	+/8	--	--
Solidago rigida	+/6	--	2/10	--
Sphaeralcea coccinea	--	--	--	+/4
Tragopogon dubius	--	--	+/2	--
Species in microplots	13	15	15	17
Coverage of shrubs	0	0	0	1
Coverage of graminoids	185	191	188	163
Coverage of forbs	9	3	6	6
Total coverage	194	194	194	170

Table A-8.—*Agropyron spicatum/Bouteloua curtipendula* and *Agropyron spicatum/Carex filifolia* habitat types.

	Agropyron/Bouteloua			*Agropyron/Carex*	
Stand number	**23**	**24**	**25**	**30**	**31**
District	A	A	A	A	A
Location					
Quarter section	SW	NW	SE	SW	SW
Section	36	4	31	6	6
Township	4S	5S	6S	5S	5S
Range	45E	47E	47E	45E	45E
Topographic position					
Slope (%)	25	37	55	4	2
Aspect (°)	155	180	90	5	35
Elevation (m)	985	1,146	1,158	1,253	1,256
		Coverage/Frequency			
Shrubs					
Artemisia cana	--	+/2	--	--	--
Artemisia frigida	--	1/4	+/4	6/30	2/22
Gutierrezia sarothrae	1/6	--	2/34	1/16	1/10
Opuntia polyacantha	*	*	--	--	+/2
Rhus aromatica	--	2/4	6/14	--	--
Yucca glauca	*	*	--	--	--
Graminoids					
Agropyron smithii	--	8/44	18/94	+/8	1/6
Agropyron spicatum	42/98	46/96	61/99	58/94	58/99
Andropogon gerardi	--	3/8	--	--	--
Andropogon scoparius	16/72	2/12	--	--	--
Aristida longiseta	*	--	--	--	--
Bouteloua curtipendula	13/70	11/66	4/16	--	--
Bouteloua gracilis	--	--	--	1/10	1/6
Bromus japonicus	+/4	--	2/36	12/44	13/70
Bromus tectorum	+/4	--	+/2	2/4	+/2
Calamovilfa longifolia	--	+/2	--	--	--
Carex eleocharis	--	--	--	+/4	+/4
Carex filifolia	4/20	1/4	--	7/32	22/78
Carex heliophila	--	--	--	6/18	--
Danthonia spicata	--	--	--	+/2	--
Koeleria pyramidata	*	*	--	8/66	6/70
Muhlenbergia cuspidata	3/24	+/2	+/2	--	--
Poa canbyi	--	--	--	1/8	7/58
Sitanion hystrix	*	+/2	--	--	--
Stipa comata	1/2	1/4	--	5/46	3/24
Stipa viridula	--	+/4	1/18	--	--
Forbs					
Achillea millefolium	--	--	--	2/28	+/2
Ambrosia psilostachya	+/6	+/6	1/14	4/56	12/94
Antennaria rosea	+/2	--	--	+/8	2/12
Artemisia ludoviciana	2/20	+/2	--	--	*
Asclepias pumila	+/6	--	--	--	--
Aster ericoides	+/2	+/2	+/6	5/42	8/62
Astragalus gilviflorus	--	+/6	--	--	--
Astragalus gracilis	+/6	--	--	--	--
Cerastium arvense	--	--	--	--	1/20
Chrysopsis villosa	1/6	--	--	*	--
Cirsium undulatum	*	--	--	+/4	1/12
Echinacea angustifolia	2/24	+/10	--	2/12	+/2
Gaura coccinea	--	+/6	+/10	+/2	+/16
Grindelia squarrosa	--	9/68	*	--	--
Helianthus rigidus	--	+/2	--	--	--
Kuhnia eupatorioides	+/2	--	--	*	--
Liatris punctata	*	*	--	*	--
Linum perenne	--	--	--	*	--
Lithospermum canescens	--	+/8	--	--	--
Lithospermum incisum	--	--	--	--	+/2
Lygodesmia juncea	+/2	1/14	+/2	--	--
Orthocarpus luteus	--	--	--	+/6	1/26

Stand number	Agropyron/Bouteloua			Agropyron/Carex	
	23	24	25	30	31
Oxytropis sericea	--	--	--	--	*
Penstemon albidus	+/2	--	--	--	--
Penstemon angustifolius	--	--	*	--	--
Penstemon gracilis	--	+/4	*	*	--
Petalostemon candidum	--	2/20	--	--	--
Petalostemon occidentale	--	*	--	--	--
Petalostemon purpureum	1/16	--	--	3/18	+/2
Phacelia hastata	--	--	*	--	--
Phlox alyssifolia	--	--	--	+/8	1/14
Phlox hoodii	1/8	+/2	--	--	--
Polygala alba	--	--	--	*	2/16
Psoralea argophylla	1/22	--	+/4	1/22	1/24
Psoralea esculenta	+/2	*	--	--	--
Psoralea tenuiflora	--	--	--	+/12	--
Ratibida columnifera	--	+/2	*	+/4	+/4
Sphaeralcea coccinea	--	+/10	2/50	--	--
Tragopogon dubius	*	--	+/8	+/4	--
Vicia americana	--	--	+/6	--	--
Bare ground	--	40/99	26/98	--	--
Species in microplots	24	29	18	28	28
Coverage of shrubs	1	3	8	7	3
Coverage of graminoids	79	72	86	100	111
Coverage of forbs	8	12	3	17	29
Total coverage	88	87	97	124	143

Table A-9.—*Artemisia tridentata/Agropyron spicatum* habitat type.

Stand number	18	96	97	98	104
District	A	A	A	A	A
Location					
Quarter section	NW	SE	NW	NW	NE
Section	4	25	22	22	22
Township	5S	6S	5S	5S	6S
Range	46E	45E	44E	44E	43E
Topographic position					
Slope (%)	9	8	55	20	70
Aspect (°)	220	55	215	160	185
Elevation (m)	1,024	1,018	1,061	1,055	1,122
	Coverage/Frequency				
Shrubs					
Artemisia cana	+/2	--	--	+/2	--
Artemisia frigida	+/4	+/2	--	1/14	+/2
Artemisia tridentata	17/56	22/68	28/72	18/56	21/60
Atriplex confertifolia	--	--	--	--	*
Gutierrezia sarothrae	7/44	2/30	+/2	3/30	+/2
Opuntia fragilis	--	--	--	*	--
Opuntia polyacantha	*	*	--	*	*
Rhus aromatica	1/8	--	--	--	+/4
Rosa arkansana	1/6	--	1/12	--	--
Symphoricarpos occidentalis	+/4	--	--	--	--
Yucca glauca	2/2	--	+/2	--	--
Graminoids					
Agropyron smithii	9/32	+/8	6/40	1/20	--
Agropyron spicatum	45/88	45/99	37/96	47/96	27/84
Aristida longiseta	*	--	+/2	+/2	--
Bouteloua curtipendula	11/40	--	--	6/16	--
Bouteloua gracilis	1/4	1/2	--	1/4	--
Bromus japonicus	--	+/8	1/14	14/88	*
Bromus tectorum	--	*	--	--	1/4
Carex heliophila	--	--	--	+/2	--
Festuca idahoensis	*	--	--	--	--

Koeleria pyramidata	4/40	13/84	2/22	5/24	--
Oryzopsis hymenoides	--	--	--	--	4/10
Poa canbyi	--	1/8	1/8	1/18	--
Poa pratensis	1/2	--	--	1/6	--
Stipa comata	1/8	1/2	--	1/4	--
Stipa viridula	1/8	+/4	1/8	13/36	--
Forbs					
Achillea millefolium	*	--	1/4	1/20	--
Allium textile	--	+/2	*	*	--
Aster ericoides	--	--	--	+/4	--
Astragalus gilviflorus	*	--	--	--	--
Camelina microcarpa	--	3/78	+/4	2/54	--
Ceratoides lanata	2/12	3/18	--	+/2	--
Comandra umbellata	+/2	--	1/10	*	--
Echinacea angustifolia	+/6	--	--	*	--
Eriogonum pauciflorum	--	--	+/2	--	--
Gaura coccinea	+/2	--	--	--	--
Grindelia squarrosa	+/2	--	--	--	--
Hedemona hispida	--	--	--	--	+/6
Linum perenne	+/6	--	+/2	4/38	--
Linum rigidum	--	+/2	--	--	--
Penstemon gracilis	*	--	--	--	--
Petalostemon candidum	*	--	--	--	--
Phacelia hastata	--	--	--	--	+/2
Phlox andicola	--	1/22	+/2	+/2	--
Phlox hoodii	+/18	--	--	--	--
Psoralea argophylla	+/8	--	--	--	--
Psoralea esculenta	--	*	--	+/4	--
Ratibida columnifera	+/2	--	--	--	--
Senecio canus	+/6	--	--	--	--
Sphaeralcea coccinea	1/22	+/2	+/2	+/12	+/10
Thermopsis rhombifolia	--	--	2/18	--	--
Tragopogon dubius	1/18	*	--	+/10	*
Vicia americana	*	--	+/16	*	+/6
Bare ground	--	26/94	44/99	14/99	--
Species in microplots	28	17	20	25	11
Coverage of shrubs	28	24	29	22	21
Coverage of graminoids	73	61	48	90	32
Coverage of forbs	4	7	4	7	0
Total coverage	105	92	81	119	53

Table A-10.—*Artemisia tridentata/Agropyron smithii* habitat type.

Stand number	59	121	124	32	34	35	105
District	S	S	S	A	A	A	A
Location							
Quarter section	SE	NE	NE	NW	NW	NW	NW
Section	26	11	19	22	9	9	4
Township	1S	2S	2S	4S	7S	7S	7S
Range	60E	60E	61E	44E	47E	47E	44E
Topographic position							
Slope (%)	2	8	5	5	3	3	10
Aspect (°)	232	317	107	20	275	275	195
Elevation (m)	1,039	1,039	1,061	986	1,219	1,219	1,219
	Coverage/Frequency						
Shrubs							
Artemisia cana	--	--	--	2/6	--	--	--
Artemisia frigida	*	1/8	+/4	2/8	*	1/6	*
Artemisia tridentata	29/86	25/96	33/92	19/54	14/42	21/56	26/72
Gutierrezia sarothrae	+/2	--	+/2	3/22	2/18	3/22	1/10
Opuntia fragilis	--	+/2	--	--	--	+/2	+/6
Opuntia polyacantha	3/24	2/28	1/14	*	*	*	--

Stand number	59	121	124	32	34	35	105
Graminoids							
Agropyron dasystachyum	+/2	--	*	--	+/2	+/2	--
Agropyron smithii	23/96	69/99	67/99	32/94	43/99	21/99	21/94
Agropyron spicatum	--	--	--	11/40	--	--	--
Aristida longiseta	--	--	--	+/4	--	--	--
Bouteloua gracilis	3/12	4/20	2/14	7/32	--	+/2	+/6
Bromus japonicus	--	1/40	+/8	11/52	13/88	10/88	5/90
Carex filifolia	--	--	--	3/20	--	--	--
Festuca idahoensis	--	--	--	--	--	*	--
Festuca octoflora	--	--	+/2	--	--	--	--
Koeleria pyramidata	+/6	1/12	1/8	3/30	21/86	18/68	19/96
Poa canbyi	--	4/40	5/48	5/38	3/18	6/20	19/80
Schedonnardus paniculatus	1/6	--	--	--	--	+/4	--
Stipa comata	+/4	--	--	2/8	--	--	--
Stipa spartea	--	--	--	--	--	+/2	--
Stipa viridula	+/6	--	*	8/48	6/40	22/78	11/54
Forbs							
Achillea millefolium	--	--	--	1/14	1/20	1/22	2/58
Antennaria rosea	--	--	--	--	3/16	+/4	--
Aster ericoides	--	--	--	1/8	--	+/2	--
Calochortus nuttallii	--	--	--	+/4	--	--	--
Camelina microcarpa	--	+/2	--	2/40	+/18	+/14	10/98
Cerastium arvense	--	--	--	--	1/8	--	--
Ceratoides lanata	--	--	--	--	--	4/38	--
Collomia linearis	--	--	--	--	--	--	+/2
Comandra umbellata	--	--	--	2/28	--	+/4	--
Echinacea angustifolia	--	--	--	+/2	--	--	--
Erigeron pumilus	--	--	--	+/2	--	--	--
Gaura coccinea	--	--	--	*	--	--	--
Hedeoma hispida	--	--	+/4	--	--	--	--
Linum perenne	--	--	--	2/20	--	--	--
Lygodesmia juncea	--	--	--	*	--	--	--
Mosses and lichens	--	--	--	--	1/18	+/4	--
Orthocarpus luteus	--	--	--	+/2	+/4	+/2	--
Penstemon gracilis	--	--	--	+/2	--	--	--
Phlox alyssifolia	--	--	--	1/12	+/8	+/10	--
Phlox andicola	+/8	--	--	--	--	--	5/70
Plantago patagonica	*	--	--	--	--	--	--
Psoralea argophylla	--	--	--	+/10	--	--	--
Psoralea esculenta	--	--	--	*	--	+/2	--
Ratibida columnifera	--	--	--	1/10	--	--	--
Selaginella densa	10/54	25/64	4/14	--	--	--	--
Sphaeralcea coccinea	--	--	+/2	+/2	+/8	+/4	+/20
Taraxacum officinale	--	--	--	--	--	2/20	--
Tragopogon dubius	--	--	*	+/2	1/22	+/6	--
Vicia americana	--	--	--	+/4	1/28	1/10	2/42
Bare ground	--	23/99	27/99	--	12/78	8/68	--
Species in microplots	12	11	13	30	18	27	15
Coverage of shrubs	32	28	34	26	16	25	27
Coverage of graminoids	27	79	75	82	86	77	75
Coverage of forbs	10	25	4	10	8	8	19
Total coverage	69	132	113	118	110	110	121

Table A-11.—*Artemisia cana/Agropyron smithii* habitat type.

Stand number	60	125	129	37	91	103
District	S	S	S	A	A	A
Location						
Quarter section	SE	NE	SW	NW	SE	SW
Section	26	29	12	25	17	18
Township	1S	2S	2S	6S	5S	3S
Range	60E	61E	60E	45E	43E	46E
Topographic position						
Slope (%)	2	8	5	2	--	2
Aspect (°)	232	357	217	130	--	125
Elevation (m)	1,030	1,088	1,049	1,036	957	951
			Coverage/Frequency			
Shrubs						
Artemisia cana	58/98	35/90	28/58	25/78	34/58	26/74
Artemisia frigida	--	--	--	1/16	+/2	+/2
Gutierrezia sarothrae	--	--	--	+/8	--	--
Opuntia fragilis	--	--	--	+/2	--	--
Rosa woodsii	--	--	--	--	--	+/2
Symphoricarpos occidentalis	*	3/28	--	--	--	1/2
Graminoids						
Agropyron smithii	76/98	77/99	83/99	32/99	77/99	84/99
Aristida longiseta	--	--	--	*	--	--
Bouteloua curtipendula	--	--	30/72	--	--	--
Bouteloua gracilis	--	3/20	+/2	40/90	--	--
Bromus japonicus	--	--	--	10/90	1/20	3/20
Buchloe dactyloides	15/30	--	20/34	--	--	--
Festuca octoflora	--	--	--	+/8	--	--
Koeleria pyramidata	--	1/30	8/70	4/24	--	--
Poa compressa	--	--	--	1/10	--	--
Poa pratensis	25/62	11/42	2/20	2/4	11/34	73/99
Poa sandbergii	--	--	--	3/22	--	--
Stipa comata	--	--	+/8	+/10	--	--
Stipa viridula	5/32	6/58	10/54	7/28	2/24	3/22
Forbs						
Achillea millefolium	2/40	+/10	1/16	+/2	1/2	13/62
Allium textile	--	--	+/2	--	--	--
Antennaria rosea	--	--	+/2	--	--	--
Artemisia dracunculus	1/4	--	--	--	--	--
Artemisia ludoviciana	--	--	--	--	2/10	--
Aster ericoides	+/4	+/2	+/4	--	--	--
Calochortus nuttallii	--	--	+/4	*	--	--
Camelina microcarpa	--	--	--	2/32	--	--
Ceratoides lanata	--	--	--	*	--	--
Cirsium undulatum	--	--	--	*	--	--
Echinacea angustifolia	--	--	*	--	--	--
Gaura coccinea	--	--	--	+/2	--	--
Lactuca oblongifolia	--	--	--	--	--	2/8
Linum rigidum	--	--	+/4	+/8	--	--
Melilotus officinalis	+/2	--	--	--	--	--
Penstemon angustifolius	--	--	--	+/2	--	--
Penstemon gracilis	--	--	--	*	--	--
Phlox alyssifolia	--	--	1/6	--	--	--
Phlox andicola	--	--	--	+/8	--	--
Psoralea argophylla	--	+/4	--	+/2	--	--
Ratibida columnifera	+/4	--	+/2	*	--	*
Taraxacum officinale	2/32	--	--	1/22	4/30	--
Tragopogon dubius	--	--	+/2	+/4	--	*
Vicia americana	+/4	--	+/20	--	--	+/2
Bare ground	--	--	--	16/99	--	--
Species in microplots	12	10	19	23	9	11
Coverage of shrubs	58	38	28	26	34	27
Coverage of graminoids	121	98	153	99	91	163
Coverage of forbs	5	0	2	3	7	15
Total coverage	184	136	183	128	132	205

Table A-12.—*Juniperus horizontalis/Carex heliophila* habitat type.

Stand number	44	45	46	48	130	140	144
District	S	S	S	S	S	S	S
Location							
Quarter section	SW	SW	NE	NE	SE	SE	SE
Section	25	25	25	25	10	24	13
Township	19N	19N	19N	19N	1S	19N	17N
Range	7E	7E	7E	7E	61E	7E	7E
Topographic position							
Slope (%)	50	52	45	45	35	80	60
Aspect (°)	7	4	17	10	27	357	17
Elevation (m)	1,073	1,073	1,076	1,073	1,079	1,067	1,085
			Coverage/Frequency				
Shrubs							
Artemisia frigida	1/22	1/20	+/6	+/6	+/6	+/16	+/4
Gutierrezia sarothrae	+/6	+/6	--	+/10	+/4	+/8	--
Juniperus communis	--	--	--	--	--	3/8	*
Juniperus horizontalis	76/99	87/99	71/94	56/70	90/99	95/99	98/99
Opuntia polyacantha	+/2	--	--	+/4	--	--	--
Prunus virginiana	--	--	1/16	--	--	+/8	*
Rhus aromatica	+/2	--	+/4	2/6	--	--	+/2
Ribes cereum	--	--	--	--	--	--	+/6
Ribes missouriense	--	--	--	--	--	+/2	--
Rosa arkansana	+/8	--	1/26	--	+/4	+/6	--
Symphoricarpos occidentalis	+/4	+/2	1/18	+/8	--	4/46	1/22
Toxicodendron rydbergii	--	--	--	--	--	+/6	--
Graminoids							
Agropyron caninum	--	--	+/2	--	+/4	--	--
Agropyron dasystachyum	1/6	9/56	+/4	1/14	--	20/86	11/68
Agropyron spicatum	--	--	--	--	13/66	--	--
Andropogon scoparius	5/20	1/4	41/92	46/99	1/10	1/6	+/2
Bouteloua curtipendula	--	--	--	1/4	--	--	--
Calamovilfa longifolia	9/30	2/4	2/18	1/6	3/16	--	--
Carex filifolia	6/42	8/30	3/24	3/20	4/14	4/30	6/36
Carex heliophila	22/74	33/96	17/90	3/52	33/99	19/64	16/74
Festuca ovina	--	--	--	--	--	--	+/12
Helictotrichon hookeri	+/2	+/2	+/14	+/10	--	--	--
Koeleria pyramidata	4/38	1/20	+/2	1/14	+/10	+/6	1/14
Muhlenbergia cuspidata	1/8	1/6	1/14	+/10	--	2/12	*
Poa arida	2/26	--	1/8	+/6	--	--	--
Poa pratensis	--	--	--	--	--	+/4	--
Poa sandbergii	--	--	--	--	--	--	*
Stipa comata	2/22	+/8	+/8	1/4	1/12	--	*
Forbs							
Achillea millefolium	1/12	+/16	+/12	+/6	*	+/8	+/6
Allium textile	--	--	--	--	+/4	--	--
Anemone cylindrica	--	+/2	+/10	+/2	+/2	+/6	--
Anemone patens	2/50	3/68	2/42	2/54	--	+/6	1/26
Antennaria rosea	--	--	--	--	--	+/2	--
Artemisia campestris	--	+/6	+/2	--	--	--	--
Artemisia dracunculus	--	--	+/2	--	+/2	--	--
Aster ericoides	--	*	+/2	+/2	1/18	--	--
Astragalus adsurgens	+/2	1/8	+/2	+/2	--	--	*
Campanula rotundifolia	1/36	1/34	1/24	1/22	+/6	+/6	1/40
Cerastium arvense	--	--	--	--	+/2	+/4	*
Chrysopsis villosa	+/2	+/2	*	--	--	--	--
Comandra umbellata	--	+/10	+/8	1/30	+/4	*	--
Echinacea angustifolia	--	--	--	+/4	--	--	--
Erigonum flavum	--	+/4	--	--	--	--	--
Galium boreale	+/6	+/4	1/24	1/24	--	2/44	1/26
Geum triflorum	+/4	1/4	--	--	+/2	+/4	+/2
Helianthus rigidus	--	--	--	1/10	--	--	--
Heuchera richardsonii	--	+/4	+/4	+/2	+/2	--	+/2
Hymenoxys acaulis	+/2	+/10	+/2	+/10	--	--	--
Linum perenne	*	--	+/2	--	--	+/4	--
Linum rigidum	--	--	--	--	*	--	--
Lupinus argenteus	1/2	--	+/2	+/4	1/10	*	*

Microseris cuspidata	--	--	--	--	--	+/4	+/2
Monarda fistulosa	--	--	+/4	--	--	+/8	--
Oxytropis lambertii	--	--	--	--	+/2	--	--
Oxytropis sericea	2/20	1/16	--	--	*	+/4	+/6
Petalostemon purpureum	1/16	+/8	4/60	2/22	+/2	+/2	--
Phlox alyssifolia	+/8	--	--	2/24	--	--	--
Psoralea esculenta	+/2	+/2	--	--	*	--	*
Selaginella densa	3/12	1/8	+/4	1/6	1/6	--	--
Senecio canus	+/6	+/2	+/10	+/6	--	+/4	--
Smilacina stellata	--	--	--	--	--	*	--
Solidago graminifolia	+/2	--	1/26	+/8	--	--	--
Solidago missouriensis	1/16	1/12	+/16	+/4	--	--	--
Solidago mollis	--	--	--	--	--	--	+/4
Solidago nemoralis	--	--	+/4	--	--	+/6	--
Thermopsis rhombifolia	+/10	2/34	3/44	5/60	+/4	5/34	2/32
Vicia americana	+/18	1/12	--	--	--	--	+/2
Species in microplots	36	34	39	37	26	32	22
Coverage of shrubs	77	88	74	58	90	102	99
Coverage of graminoids	52	55	65	57	55	46	34
Coverage of forbs	12	12	12	16	3	7	5
Total coverage	141	155	151	131	148	155	138

Table A-13.—*Rhus aromatica/Agropyron spicatum* and *Rhus aromatica/Festuca idahoensis* habitat types.

	Rhus/Agropyron					*Rhus/Festuca*	
Stand number	**111**	**131**	**33**	**36**	**39**	**87**	**88**
District	S	S	A	A	A	A	A
Location							
Quarter section	NE	NW	SW	SE	NW	SE	NE
Section	27	32	7	7	21	35	35
Township	2S	20N	7S	7S	6S	6S	6S
Range	62E	1E	47E	47E	45E	43E	43E
Topographic position							
Slope (%)	65	60	53	55	52	15	10
Aspect (°)	157	87	185	170	130	25	50
Elevation (m)	1,024	1,018	1,177	1,170	1,183	1,207	1,207
	Coverage/Frequency						
Shrubs							
Artemisia cana	+/8	4/18	--	--	--	--	--
Artemisia frigida	+/4	+/2	--	*	--	2/16	1/2
Artemisia tridentata	--	--	--	--	+/2	--	--
Chrysothamnus nauseosus	--	+/2	--	--	--	--	--
Gutierrezia sarothrae	--	1/6	1/6	--	--	3/16	1/4
Opuntia fragilis	--	--	--	--	--	*	--
Opuntia polyacantha	--	--	--	--	--	+/2	*
Rhus aromatica	28/66	36/70	29/54	27/50	31/56	25/30	22/34
Rosa arkansana	--	--	--	--	+/4	--	--
Yucca glauca	+/4	--	--	*	--	--	--
Graminoids							
Agropyron smithii	3/30	+/2	3/30	10/68	9/60	+/2	+/2
Agropyron spicatum	34/96	33/92	47/86	49/96	36/86	61/96	51/78
Andropogon scoparius	1/6	--	--	--	+/2	--	--
Aristida longiseta	+/2	*	--	1/2	--	--	--
Bouteloua curtipendula	14/48	--	13/36	3/14	7/32	1/10	3/12
Bouteloua gracilis	4/22	4/18	--	--	--	--	--
Bromus japonicus	*	--	--	1/16	13/34	16/94	23/64
Bromus tectorum	--	--	+/2	1/6	5/20	2/4	--
Calamovilfa longifolia	1/8	--	--	--	--	--	--
Carex filifolia	*	--	--	--	--	--	--
Carex heliophila	--	--	--	--	--	7/24	19/48

Stand number	Rhus/Agropyron					Rhus/Festuca	
	111	131	33	36	39	87	88
Distichlis spicata	--	*	--	--	--	--	--
Festuca idahoensis	--	--	--	--	--	4/16	26/54
Koeleria pyramidata	--	*	--	--	+/2	2/18	2/16
Muhlenbergia cuspidata	+/2	*	1/4	--	--	--	--
Oryzopsis hymenoides	+/2	1/6	--	--	--	--	--
Poa canbyi	--	--	--	--	--	12/38	4/16
Poa pratensis	--	--	--	+/2	--	--	--
Stipa comata	2/12	--	--	--	--	2/14	1/10
Stipa viridula	--	+/4	--	+/2	--	--	--
Forbs							
Achillea millefolium	--	--	--	--	*	+/4	*
Ambrosia psilostachya	*	--	5/40	1/14	1/20	1/8	2/28
Antennaria parvifolia	--	--	--	--	*	--	--
Artemisia dracunculus	--	--	--	--	--	--	1/4
Artemisia ludoviciana	--	--	--	--	--	1/6	--
Aster ericoides	--	--	+/2	2/12	*	+/4	+/2
Astragalus adsurgens	--	+/2	--	--	--	--	--
Cerastium arvense	--	--	--	--	--	1/8	1/4
Chrysopsis villosa	--	*	--	--	--	--	--
Cirsium undulatum	+/2	--	--	--	--	--	--
Eriogonum pauciflorum	--	+/2	--	--	--	--	--
Gaura coccinea	+/4	+/2	--	+/8	+/2	+/2	--
Hedeoma hispida	--	+/4	--	--	--	--	--
Kuhnia eupatorioides	--	+/2	--	--	--	--	--
Liatris punctata	--	+/2	--	--	--	--	--
Linum perenne	--	--	--	*	*	--	--
Lygodesmia juncea	--	--	--	--	+/2	--	--
Melilotus albus	--	1/4	--	--	--	--	--
Melilotus officinalis	--	8/42	--	+/2	--	--	--
Oxytropis sericea	--	--	--	--	--	+/8	--
Penstemon angustifolius	--	--	--	--	*	--	--
Phacelia hastata	--	--	1/4	--	--	--	--
Phlox hoodii	--	--	--	--	--	+/4	2/14
Psoralea argophylla	*	--	--	1/32	*	1/8	+/8
Sphaeralcea coccinea	1/18	--	1/8	+/18	+/8	--	--
Tragopogon dubius	+/4	*	--	*	--	--	--
Vicia americana	--	--	+/18	+/4	+/8	--	--
Bare ground	22/60	48/99	24/78	27/86	18/70	--	--
Species in microplots	18	18	12	16	15	23	18
Coverage of shrubs	28	41	30	27	31	30	24
Coverage of graminoids	59	38	64	65	70	107	129
Coverage of forbs	1	9	7	4	1	4	6
Total coverage	88	88	101	96	102	141	159

Table A-14.—*Rhus aromatica/Carex filifolia* habitat type.

Stand number	142	143	145	146
District	S	S	S	S
Location				
Quarter section	SE	SE	NW	SE
Section	21	21	24	23
Township	16N	16N	17N	17N
Range	9E	9E	7E	7E
Topographic position				
Slope (%)	30	20	20	60
Aspect (°)	357	322	177	177
Elevation (m)	1,000	1,006	1,097	1,085

	Coverage/Frequency			
Shrubs				
Artemisia cana	--	--	--	+/2
Artemisia frigida	4/46	5/54	5/68	2/26
Gutierrezia sarothrae	--	+/8	+/14	+/4
Juniperus horizontalis	--	--	--	+/2
Opuntia polyacantha	*	+/8	1/6	2/16
Rhus aromatica	35/48	29/40	22/38	15/28
Rosa arkansana	--	--	1/12	1/8
Symphoricarpos occidentalis	+/8	--	--	--
Toxicodendron rydbergii	3/8	--	--	--
Graminoids				
Agropyron dasystachyum	1/4	+/6	6/24	7/28
Andropogon scoparius	+/2	1/4	--	1/8
Bouteloua gracilis	--	1/10	15/50	2/10
Bromus japonicus	--	--	--	+/2
Calamovilfa longifolia	12/40	--	--	+/2
Carex filifolia	40/78	52/96	40/92	41/96
Carex heliophila	34/60	18/50	--	--
Koeleria pyramidata	3/30	6/46	6/44	+/8
Muhlenbergia cuspidata	22/50	25/68	1/8	8/44
Poa sandbergii	--	--	+/2	--
Stipa comata	11/44	6/40	13/66	1/10
Stipa viridula	--	--	1/4	--
Forbs				
Achillea millefolium	+/2	--	*	--
Allium textile	--	--	*	--
Anemone patens	+/2	--	+/2	+/2
Antennaria rosea	*	--	--	--
Artemisia campestris	--	1/4	+/4	--
Artemisia dracunculus	+/2	+/2	+/8	2/16
Aster ericoides	2/22	*	+/2	2/12
Astragalus adsurgens	1/10	+/2	1/4	*
Campanula rotundifolia	+/2	--	--	--
Cerastium arvense	--	--	+/2	--
Cirsium undulatum	1/8	*	+/2	+/4
Comandra umbellata	--	+/2	+/8	+/2
Echinacea angustifolia	+/2	1/10	+/4	+/2
Eriogonum flavum	--	+/2	--	--
Eriogonum pauciflorum	--	--	+/2	+/6
Gaura coccinea	--	+/2	--	+/2
Hedeoma hispida	--	--	+/2	--
Helianthus rigidus	+/2	*	--	--
Liatris punctata	+/2	+/4	*	--
Lupinus argenteus	--	--	3/4	--
Microseris cuspidata	+/6	+/20	+/2	*
Orthocarpus luteus	+/2	+/4	--	--
Oxytropis lambertii	--	--	--	+/2
Oxytropis sericea	--	--	+/2	--
Petalostemon purpureum	+/10	+/10	+/14	+/4
Phlox andicola	+/2	+/2	+/4	+/6
Phlox hoodii	--	--	*	+/4
Psoralea argophylla	+/2	--	--	--
Psoralea esculenta	--	--	+/6	--
Psoralea tenuiflora	+/2	--	--	*
Selaginella densa	--	*	--	--
Solidago missouriensis	--	*	--	+/8
Sphaeralcea coccinea	+/2	--	--	+/2
Tragopogon dubius	--	--	+/2	*
Bare ground	--	9/66	14/92	23/94
Species in microplots	29	24	31	30
Coverage of shrubs	42	34	29	20
Coverage of graminoids	123	109	82	60
Coverage of forbs	4	2	4	4
Total coverage	169	145	115	84

Table A-15.—*Sarcobatus vermiculatus*/*Agropyron spicatum* and *Sarcobatus vermiculatus*/*Agropyron smithii* habitat types.

	Sarcobatus vermiculatus/ Agropyron spicatum			*Sarcobatus vermiculatus/ Agropyron smithii*	
Stand number	**95**	**99**	**101**	**92**	**93**
District	A	A	A	A	A
Location					
Quarter section	SE	NW	SW	SE	SE
Section	13	4	10	5	4
Township	7S	5S	5S	7S	7S
Range	45E	44E	43E	43E	43E
Topographic position					
Slope (%)	45	80	70	3	5
Aspect (°)	265	225	185	335	210
Elevation (m)	1,061	1,042	975	1,006	1,000
	Coverage/Frequency				
Shrubs					
Artemisia frigida	--	--	--	*	--
Artemisia tridentata	1/8	8/24	3/14	--	--
Atriplex confertifolia	8/28	9/32	4/18	--	--
Chrysothamnus nauseosus	*	--	*	--	--
Gutierrezia sarothrae	1/4	3/28	*	--	--
Opuntia polyacantha	--	--	*	*	*
Sarcobatus vermiculatus	29/76	24/76	24/64	30/74	17/50
Graminoids					
Agropyron cristatum	--	--	--	--	+/4
Agropyron dasystachyum	--	--	3/4	--	--
Agropyron smithii	--	+/14	--	52/98	49/99
Agropyron spicatum	22/72	16/60	11/50	--	--
Bouteloua gracilis	--	--	--	+/2	--
Bromus japonicus	+/6	--	--	24/99	52/99
Bromus tectorum	--	--	--	7/16	--
Koeleria pyramidata	--	--	--	*	--
Oryzopsis hymenoides	1/6	+/4	--	--	--
Poa canbyi	+/2	--	--	15/78	8/48
Stipa viridula	--	--	--	--	2/4
Forbs					
Achillea millefolium	--	--	--	*	+/2
Camelina microcarpa	--	--	--	2/54	1/42
Erigonum pauciflorum	+/6	--	*	--	--
Suaeda depressa	--	1/26	--	--	--
Bare ground	52/94	76/99	77/99	--	--
Species in microplots	9	8	5	7	8
Coverage of shrubs	39	44	31	30	17
Coverage of graminoids	23	16	14	98	111
Coverage of forbs	0	1	0	2	1
Total coverage	62	61	45	130	129

Table A-16.—*Juniperus scopulorum/Agropyron spicatum* habitat type.

Stand number	89	90	94	100
District	A	A	A	A
Location				
Quarter section	NE	SE	SE	SW
Section	10	4	13	10
Township	7S	7S	7S	5S
Range	43E	43E	45E	43E
Topographic position				
Slope (%)	40	38	48	45
Aspect (°)	345	325	310	345
Elevation (m)	1,024	1,024	1,049	988
		Coverage/Frequency		
Shrubs				
Artemisia cana	+/2	*	--	--
Artemisia filifolia	--	*	--	+/2
Artemisia frigida	--	*	*	--
Artemisia tridentata	--	--	--	1/4
Gutierrezia sarothrae	+/4	+/16	+/2	+/4
Opuntia fragilis	--	--	--	*
Opuntia polyacantha	*	*	--	*
Prunus virginiana	*	2/4	*	--
Rhus aromatica	+/4	--	3/8	*
Ribes odoratum	--	--	*	--
Rosa woodsii	+/2	+/2	--	+/2
Sarcobatus vermiculatus	--	--	--	*
Symphoricarpos occidentalis	3/28	+/2	1/8	*
Graminoids				
Agropyron caninum	--	--	+/2	--
Agropyron smithii	--	--	2/6	--
Agropyron spicatum	40/94	26/96	29/98	18/92
Andropogon scoparius	--	--	*	1/2
Aristida longiseta	--	--	--	2/8
Bouteloua curtipendula	3/20	*	1/18	--
Bromus inermis	--	+/8	--	--
Bromus japonicus	+/2	--	1/14	--
Bromus tectorum	--	--	+/2	--
Calamovilfa longifolia	4/22	--	--	2/6
Carex filifolia	--	--	*	1/4
Carex heliophila	+/4	--	2/24	2/20
Koeleria pyramidata	+/12	+/4	+/2	+/12
Oryzopsis hymenoides	--	*	--	+/2
Oryzopsis micrantha	--	+/2	5/28	--
Poa canbyi	*	--	--	+/4
Poa pratensis	--	--	2/10	--
Stipa viridula	--	--	*	--
Forbs				
Achillea millefolium	+/14	+/18	1/20	2/18
Anemone patens	--	--	--	+/2
Antennaria rosea	*	--	+/2	+/2
Artemisia ludoviciana	+/2	*	--	--
Aster ericoides	+/2	--	--	--
Astragalus adsurgens	+/6	2/22	--	1/8
Camelina microcarpa	--	--	--	*
Campanula rotundifolia	+/6	*	+/6	+/8
Cerastium arvense	1/22	1/16	1/8	--
Ceratoides lanata	--	*	--	+/2
Comandra umbellata	+/16	1/16	--	--
Erigonum pauciflorum	--	+/2	--	--
Gaura coccinea	--	+/2	--	--
Geum triflorum	+/2	1/2	--	--
Hedeoma drummondii	--	--	*	--
Hymenopappus filifolius	*	--	--	--
Liatrus punctata	--	--	--	+/2
Linum perenne	--	--	+/2	--
Linum rigidum	*	*	--	+/2
Melilotus officinalis	--	--	*	--

Stand number	89	90	94	100
Mosses and lichens	--	--	7/22	2/14
Oxytropis sericea	--	+/2	+/6	+/4
Petalostemon villosum	--	+/2	--	--
Phlox hoodii	--	+/6	--	--
Polygala alba	+/2	--	+/6	+/4
Senecio canus	+/2	--	--	--
Smilacina stellata	+/10	--	--	--
Solidago missouriensis	1/12	*	+/2	+/6
Solidago rigida	+/4	+/4	--	--
Thermopsis rhombifolia	*	--	--	--
Vicia americana	*	--	--	--
Bare ground	62/98	64/99	46/92	70/99
Rocks	3/18	5/14	--	--
Species in microplots	24	19	22	25
Coverage of species	3	2	4	1
Coverage of graminoids	47	26	42	26
Coverage of forbs	2	5	9	5
Total coverage	52	33	55	32

Table A-17.—*Juniperus scopulorum/Oryzopsis micrantha* habitat type.

Stand number	123	126	128
District	S	S	S
Location			
Quarter section	SW	NE	NW
Section	20	1	1
Township	2S	2S	2S
Range	61E	60E	60E
Topographic position			
Slope (%)	30	55	65
Aspect (°)	27	317	337
Elevation (m)	1,097	1,085	1,024
	Coverage/Frequency		
Shrubs			
Artemisia frigida	+/6	+/2	+/4
Artemisia tridentata	*	--	--
Berberis repens	3/50	1/8	+/2
Chrysothamnus nauseosus	+/2	--	*
Juniperus communis	--	*	7/20
Rhus aromatica	*	*	1/6
Ribes cereum	2/8	+/4	+/4
Ribes odoratum	*	*	--
Rosa woodsii	*	+/2	--
Symphoricarpos albus	1/26	2/26	1/2
Symphoricarpos occidentalis	--	+/2	+/8
Toxicodendron rydbergii	--	--	+/2
Graminoids			
Agropyron caninum	2/26	2/6	1/14
Agropyron dasystachyum	--	--	+/4
Agropyron spicatum	--	+/2	--
Andropogon scoparius	--	+/4	--
Bromus japonicus	1/16	--	+/2
Carex filifolia	--	--	*
Carex heliophila	1/24	1/6	2/20
Koeleria pyramidata	+/4	*	+/4
Muhlenbergia cuspidata	*	--	--
Oryzopsis micrantha	61/94	38/96	40/86
Poa canbyi	--	--	2/8
Poa sandbergii	*	+/2	--
Stipa occidentalis	+/6	--	--
Stipa viridula	--	--	+/2
Forbs			
Achillea millefolium	1/22	+/6	1/20
Anemone patens	--	+/2	--
Antennaria parvifolia	--	--	+/2
Antennaria rosea	+/10	1/10	+/10
Arabis hirsuta	+/14	--	--
Astragalus adsurgens	--	--	2/6
Astragalus racemosus	--	--	1/4
Campanula rotundifolia	+/18	+/2	2/40
Cerastium arvense	1/24	+/6	--
Disporum trachycarpum	--	*	--
Galium boreale	--	+/2	+/6
Geum triflorum	--	+/2	--
Hedeoma hispida	+/2	--	--
Heuchera richardsonii	+/2	*	--
Mosses and lichens	--	43/78	+/6
Oxytropis lambertii	--	--	*
Smilacina stellata	4/64	*	4/34
Solidago missouriensis	+/2	+/2	1/20
Bare ground	48/99	34/74	49/98
Species in microplots	20	21	26
Coverage of shrubs	6	3	9
Coverage of graminoids	65	41	45
Coverage of forbs	6	44	11
Total coverage	77	88	65

Table A-18.—*Fraxinus pennsylvanica/Prunus virginiana* habitat type.

Stand number	7	9	15	68	72	84	47	115	120	147	27	28	85	110
District	G	G	G	G	G	G	S	S	S	S	A	A	A	A
Location														
Quarter section	SE	NE	NE	SW	SE	SE	SW	NE	SE	SW	SE	SE	SE	SW
Section	14	31	33	5	28	28	25	33	31	6	22	22	26	35
Township	20N	19N	19N	20N	20N	22N	19N	1N	2S	16N	3S	3S	7S	5S
Range	15E	13E	18E	16E	13E	13E	7E	58E	62E	8E	47E	47E	46E	44E
Topographic position														
Slope (%)	10	7	3	2	4	5	18	8	7	40	2	2	7	3
Aspect (°)	253	93	338	18	8	33	282	47	357	347	260	260	305	355
Elevation (m)	--	--	--	--	--	--	1,036	1,146	1,085	1,091	1,155	1,155	1,128	1,091
							Coverage/Frequency							
Shrubs														
Amelanchier alnifolia	7/14	--	--	1/2	--	--	+/2	--	--	8/24	•	6/8	--	--
Amelanchier sanguinea	2/4	•	--	--	•	1/4	+/2	--	2/6	3/10	--	--	2/6	--
Artemisia frigida	--	--	--	•	--	+/2	•	--	--	--	--	--	--	--
Berberis repens	--	--	--	--	--	--	--	14/72	+/2	--	19/54	32/94	3/26	•
Celastrus scandens	--	--	--	--	--	7/32	--	--	--	--	--	--	--	--
Clematis ligusticifolia	--	--	--	--	--	4/18	--	--	•	--	--	--	--	1/6
Cornus stolonifera	--	--	--	--	--	--	+/6	--	--	--	--	--	--	--
Crataegus succulenta	--	--	--	•	•	--	--	+/2	8/12	--	20/30	5/10	4/6	•
Juniperus communis	--	--	--	--	--	--	--	--	--	2/4	--	--	--	--
Parthenocissus vitacea	3/12	--	+/2	•	--	1/10	+/2	--	--	+/4	--	•	--	--
Prunus americana	--	--	12/38	•	•	--	--	1/4	•	•	13/36	5/18	•	8/12
Prunus virginiana	75/94	43/58	--	29/70	70/96	55/84	87/99	88/98	14/50	79/99	79/96	70/99	5/24	46/78
Rhus aromatica	•	--	--	--	•	•	--	--	--	+/2	--	--	--	--
Ribes americanum	--	--	--	--	--	--	1/6	--	+/2	--	--	--	1/2	--
Ribes cereum	--	--	--	--	--	--	--	--	•	--	--	--	--	--
Ribes missouriense	--	--	--	--	--	--	+/2	•	•	+/4	--	--	1/8	2/6
Ribes odoratum	1/8	•	--	•	•	•	+/2	--	9/26	•	8/22	1/6	--	1/6
Ribes setosum	--	+/2	--	--	--	--	--	--	--	--	3/22	3/32	--	--
Rosa acicularis	3/14	--	--	--	--	--	--	--	--	--	--	--	--	--
Rosa woodsii	3/8	--	--	•	--	1/8	+/6	--	+/2	+/4	6/26	4/14	--	•
Rubus idaeus	--	--	--	--	--	--	•	+/2	•	--	--	--	--	--
Shepherdia argentea	--	•	--	--	--	--	--	--	--	--	--	--	--	--
Symphoricarpos albus	--	--	--	--	--	--	--	--	--	--	6/30	6/34	--	--
Symphoricarpos occidentalis	22/46	5/32	2/14	+/6	•	30/84	1/18	--	2/12	2/16	--	4/24	1/6	•
Toxicodendron rydbergii	3/8	--	•	+/4	--	3/12	1/10	1/12	3/20	+/4	--	--	•	•
Vitis vulpina	--	--	--	•	•	--	--	--	--	--	--	--	--	--
Graminoids														
Agropyron caninum	+/4	7/30	--	16/78	+/2	35/68	+/2	--	3/10	2/10	+/4	+/2	--	--
Bouteloua curtipendula	--	--	--	--	--	--	--	•	--	--	--	--	--	--
Bromus carinatus	--	--	--	2/18	--	--	--	--	--	--	--	--	--	--
Bromus inermis	+/2	19/24	--	--	--	3/4	--	--	--	--	--	--	--	•
Bromus japonicus	--	+/2	--	--	20/52	--	--	--	5/18	--	--	--	--	--
Bromus tectorum	--	--	--	--	2/10	--	--	--	--	--	--	--	--	--
Carex gravida	1/4	1/4	1/8	1/12	2/6	--	--	--	5/6	--	--	--	--	--
Carex sprengelii	3/6	7/12	77/90	8/28	26/50	+/2	46/88	52/80	1/2	30/52	41/62	21/44	56/74	74/96
Elymus canadensis	--	--	--	--	--	--	9/46	20/62	1/6	--	--	--	--	•
Elymus virginicus	23/50	46/76	14/56	--	9/36	6/18	--	1/6	26/68	39/98	3/16	3/14	1/8	25/64
Muhlenbergia racemosa	--	--	--	--	--	--	--	--	4/18	--	--	--	--	--
Oryzopsis micrantha	41/58	9/18	--	--	1/6	11/28	+/4	--	--	2/12	--	--	--	--
Poa compressa	--	--	--	--	--	--	--	--	--	2/12	--	--	--	--
Poa palustris	--	--	--	--	--	--	2/8	--	2/4	--	--	--	--	--
Poa pratensis	4/10	27/54	--	52/80	37/70	5/14	--	--	48/72	•	17/30	8/20	--	1/6
Poa sandbergii	--	--	--	--	--	--	--	--	--	•	--	--	--	--
Stipa viridula	•	1/2	--	--	1/4	--	--	--	--	--	--	--	--	--
Forbs														
Achillea millefolium	--	•	--	--	1/6	--	+/2	--	1/2	+/2	--	--	--	--
Ambrosia psilostachya	--	--	--	+/4	--	--	--	--	--	--	--	--	--	--
Ambrosia trifida	--	--	1/14	--	--	--	--	--	--	--	--	--	--	--
Apocynum androsaemifolium	--	--	--	--	--	•	--	--	1/4	--	--	--	--	--
Arctium minus	--	44/72	--	--	--	--	--	--	•	--	--	--	+/2	--
Artemisia ludoviciana	--	•	--	--	•	--	--	--	•	--	--	--	--	--
Campanula rotundifolia	--	--	--	--	--	--	+/2	--	--	--	--	--	--	--
Chenopodium album	--	--	+/2	+/2	--	--	--	--	--	--	--	--	--	--
Convolvulus arvense	--	--	+/8	+/4	1/10	--	+/2	--	1/16	--	+/2	--	--	--
Cystopteris fragilis	4/18	--	--	--	--	--	8/84	--	--	--	--	--	1/4	--
Disporum trachycarpum	+/6	--	--	--	--	--	+/2	--	•	•	--	1/16	+/6	•
Erysimum cheiranthoides	--	--	1/6	--	--	--	--	--	--	--	--	--	--	--
Fragaria virginiana	--	--	--	--	--	--	+/10	--	--	3/36	--	•	--	--
Galium aparine	4/32	9/42	6/36	9/60	22/90	--	+/8	1/10	--	--	11/48	5/34	19/56	3/12
Galium boreale	--	--	--	--	--	--	3/28	+/2	13/48	4/36	•	9/40	--	1/6
Geum canadense	--	--	--	--	--	--	--	--	--	--	--	--	•	--
Hackelia deflexa	--	+/2	10/36	•	•	+/2	1/10	•	+/2	--	--	--	--	+/2
Hackelia floribunda	--	--	--	--	--	--	--	--	--	--	1/8	•	1/12	•
Hesperis matronalis	--	--	--	--	--	--	--	--	--	--	--	--	35/80	--
Heuchera richardsonii	--	--	--	--	--	--	+/2	--	--	3/14	--	--	--	--
Humulus lupulus	--	--	--	--	--	--	--	--	--	--	--	--	•	--
Lactuca oblongifolia	--	--	--	--	2/14	+/2	--	--	+/6	--	--	--	--	--
Lactuca serriola	--	--	--	--	--	--	--	--	--	--	•	--	--	--
Melilotus officinalis	•	+/2	+/6	6/54	6/34	21/72	--	--	--	--	--	--	--	--

Stand number	7	9	15	68	72	84	47	115	120	147	27	28	85	110
Mirabilis nyctaginea	--	--	--	--	*	--	--	--	--	--	--	--	--	--
Monarda fistulosa	+/6	*	+/2	*	*	2/10	+/2	--	6/26	*	+/4	*	--	*
Mosses and lichens	*	--	--	--	--	--	--	--	--	--	--	--	--	--
Nepeta cataria	--	+/6	*	--	--	--	--	--	4/18	--	--	--	+/2	--
Osmorhiza claytonii	--	--	--	--	--	--	--	1/8	--	--	--	--	--	--
Osmorhiza longistylis	--	--	2/28	--	--	--	3/28	--	+/2	--	+/4	1/10	27/82	--
Parietaria pennsylvanica	5/36	4/36	2/12	1/18	2/18	1/4	+/12	--	+/4	--	4/20	--	--	--
Polygonatum biflorum	1/8	--	--	--	--	--	--	--	--	--	--	+/2	--	--
Ranunculus abortivus	--	--	--	+/2	--	--	--	--	--	--	--	--	+/4	--
Ranunculus cymbalaria	--	--	+/2	--	--	--	--	--	--	--	--	--	--	--
Sanicula marilandica	--	--	--	--	--	--	--	1/14	1/2	--	--	--	--	11/48
Smilacina stellata	21/58	+/4	2/16	--	+/4	3/24	+/18	1/16	1/14	5/64	3/26	2/24	2/18	--
Smilax herbacea	2/14	--	1/6	*	2/8	+/2	--	--	*	*	*	1/8	*	3/14
Solidago canadensis	--	--	--	--	--	4/18	--	--	--	--	--	--	--	--
Solidago missouriensis	--	--	--	--	--	--	2/8	--	--	--	--	--	--	--
Taraxacum officinale	--	4/34	+/4	10/72	6/40	1/6	+/4	--	--	--	--	--	1/6	--
Thalictrum dasycarpum	--	--	2/10	--	1/10	--	*	2/26	+/4	1/4	+/2	2/4	+/8	1/14
Thalictrum venulosum	--	--	--	--	--	--	*	--	--	--	*	--	--	+/4
Tragopogon dubius	--	1/4	--	*	--	--	--	--	--	--	--	--	--	--
Urtica dioica	--	--	*	--	--	--	*	+/6	--	--	--	--	2/12	--
Vicia americana	+/2	--	--	--	--	--	--	--	--	--	--	--	--	--
Viola canadensis	--	--	--	--	--	*	--	1/16	*	--	28/58	--	--	6/8
Viola pratincola	1/10	+/2	--	--	--	--	--	--	--	--	--	--	--	--
Species in microplots	26	22	21	17	20	24	32	17	31	21	21	22	22	16
Coverage of shrubs	119	48	14	30	70	102	90	104	38	94	154	136	17	58
Coverage of graminoids	72	117	92	79	98	60	57	73	95	75	61	32	57	100
Coverage of forbs	38	62	27	26	43	32	17	7	28	16	47	21	88	25
Total coverage	229	227	133	135	211	194	164	184	161	185	262	189	162	183

Table A-19.—Disturbed stands of the *Fraxinus pennsylvanica*/*Prunus virginiana* habitat type.

Stand number	166	167	168
District	S	G	S
Location			
Quarter Section	NE	NW	NE
Section	11	13	31
Township	3S	20N	17N
Range	61E	15E	8E
Topographic position			
Slope (%)	2	2	2
Aspect (°)	177	68	177
Elevation (m)	1,109	--	994
	Coverage/Frequency		
Shrubs			
Artemisia cana	--	--	2/14
Artemisia frigida	--	+/4	1/16
Berberis repens	+/2	--	--
Crataegus succulenta	9/32	*	--
Opuntia polyacantha	--	--	1/2
Prunus virginiana	+/2	*	--
Ribes americanum	--	--	*
Ribes missouriense	*	--	--
Ribes odoratum	+/2	--	--
Rosa woodsii	--	*	--
Symphoricarpos albus	+/2	--	--
Symphoricarpos occidentalis	6/56	4/24	7/42
Graminoids			
Agropyron caninum	22/56	9/40	--
Agropyron cristatum	--	*	--
Agropyron smithii	--	--	18/99
Bouteloua gracilis	--	--	4/6
Bromus carinatus	2/16	--	--
Bromus japonicus	1/18	+/2	1/26
Bromus mollis	+/2	--	--
Carex gravida	+/4	--	--
Elymus virginicus	3/12	--	--
Poa compressa	--	9/48	--
Poa pratensis	87/99	86/99	77/99
Stipa viridula	7/20	+/4	2/26
Forbs			
Achillea millefolium	3/52	+/8	2/44
Artemisia dracunculus	--	--	*
Artemisia ludoviciana	+/4	+/2	--
Aster ericoides	*	--	1/18
Cerastium arvense	+/2	--	--
Collomia linearis	+/2	--	--
Galium boreale	2/10	--	--
Grindelia squarrosa	--	+/2	1/12
Monarda fistulosa	1/12	1/4	--
Nepeta cataria	--	*	--
Potentilla gracilis	+/2	--	--
Ratibida columnifera	*	*	--
Smilacina stellata	*	--	--
Smilax herbacea	*	--	--
Solidago rigida	--	+/2	--
Taraxacum officinale	+/2	--	--
Tragopogon dubius	*	+/4	--
Vicia americana	2/18	--	--
Bare ground	--	4/6	10/90
Fallen trees	--	8/16	--
Species in microplots	23	13	12
Coverage of shrubs	15	4	11
Coverage of graminoids	122	104	102
Coverage of forbs	8	1	4
Total coverage	145	109	117

Table A-20.—*Populus tremuloides/Berberis repens* habitat type.

Stand number	53	54	114	117
District	S	S	S	S
Location				
Quarter section	NW	SW	NW	NE
Section	31	36	20	20
Township	2S	2S	1N	1N
Range	62E	61E	58E	58E
Topographic position				
Slope (%)	2	7	2	15
Aspect (°)	347	2	267	52
Elevation (m)	1,097	1,134	1,164	1,170
		Coverage/Frequency		
Shrubs				
Amelanchier alnifolia	13/38	+/2	--	--
Amelanchier sanguinea	--	--	+/4	2/32
Berberis repens	47/96	27/94	52/99	56/99
Cornus stolonifera	--	*	--	--
Crataegus chrysocarpa	2/6	+/8	--	--
Crataegus succulenta	--	--	*	--
Juniperus communis	--	*	--	--
Parthenocissus vitacea	1/8	--	--	--
Prunus americana	*	1/4	--	--
Prunus virginiana	2/28	10/52	5/40	4/46
Rhus aromatica	--	*	--	--
Ribes missouriense	+/4	+/2	1/8	1/8
Ribes odoratum	--	*	--	--
Rosa acicularis	--	--	--	*
Rosa woodsii	*	+/2	--	--
Rubus idaeus	+/4	5/30	2/28	2/26
Symphoricarpos albus	6/54	2/12	2/24	7/56
Symphoricarpos occidentalis	1/10	1/14	4/52	*
Toxicodendron rydbergii	+/6	2/24	3/34	+/6
Graminoids				
Agropyron caninum	--	*	+/4	6/30
Bromus ciliatus	--	9/48	--	--
Bromus kalmii	1/6	10/22	--	--
Carex gravida	+/2	--	2/4	--
Carex sprengelii	3/8	8/46	25/66	--
Carex xerantica	--	1/28	--	--
Danthonia spicata	--	--	*	+/2
Elymus canadensis	--	--	1/4	1/4
Elymus virginicus	7/52	12/74	2/16	--
Muhlenbergia racemosa	*	--	--	--
Poa pratensis	36/62	4/12	23/66	81/99
Schizachne purpurascens	--	--	14/68	9/42
Stipa occidentalis	--	--	--	*
Forbs				
Achillea millefolium	*	+/2	--	+/2
Apocynum androsaemifolium	2/16	--	+/4	4/54
Campanula rotundifolia	+/2	+/2	+/2	--
Cystopteris fragilis	+/4	--	--	--
Disporum trachycarpum	+/2	+/4	+/6	*
Fragaria virginiana	*	2/20	--	+/2
Galium aparine	--	--	1/20	--
Galium boreale	12/74	5/44	2/40	5/56
Galium triflorum	--	6/50	--	--
Hackelia deflexa	--	+/2	--	--
Heuchera richardsonii	*	--	--	--
Lupinus argenteus	--	--	--	*
Lysimachia ciliata	--	3/48	--	--
Melilotus officinalis	+/2	--	--	--
Monarda fistulosa	*	1/6	+/6	1/6
Osmorhiza longistylis	+/2	3/12	--	--
Parietaria pennsylvanica	+/2	--	--	--
Ranunculus abortivus	--	1/10	--	--
Sanicula marilandica	2/48	2/16	--	1/10

Stand number	53	54	114	117
Smilacina stellata	+/14	+/4	+/10	+/2
Smilax herbacea	--	--	+/2	--
Solidago missouriensis	--	--	--	*
Taraxacum officinale	+/6	+/18	--	--
Thalictrum dasycarpum	2/18	3/38	--	1/12
Thermopsis rhombifolia	--	--	--	+/10
Tragopogon dubius	*	--	--	--
Viola canadensis	--	2/16	--	--
Species in microplots	27	33	23	21
Coverage of shrubs	72	48	69	72
Coverage of graminoids	47	44	67	97
Coverage of forbs	18	28	3	12
Total coverage	137	120	139	181

Table A-21.—*Pinus ponderosa/Agropyron spicatum* habitat type.

Stand number	165	152	154
District	S	A	A
Location			
Quarter section	SE	NE	SW
Section	15	2	23
Township	3S	4S	3S
Range	62E	47E	47E
Topographic position			
Slope (%)	43	35	35
Aspect (°)	85	200	170
Elevation (m)	1,049	1,225	1,231
	Coverage/Frequency		
Shrubs			
Artemisia frigida	+/2	+/4	--
Opuntia polyacantha	*	--	--
Prunus virginiana	*	--	--
Rhus aromatica	2/8	1/6	1/2
Ribes cereum	*	--	--
Ribes missouriense	--	*	--
Rosa acicularis	--	+/2	--
Graminoids			
Agropyron smithii	--	--	*
Agropyron spicatum	43/96	17/88	37/84
Andropogon gerardi	+/2	--	*
Andropogon scoparius	--	--	1/12
Bouteloua curtipendula	3/20	--	1/6
Bromus japonicus	+/2	--	--
Bromus tectorum	*	--	*
Calamovilfa longifolia	1/6	--	*
Carex filifolia	6/31	--	--
Carex heliophila	4/36	2/14	38/90
Festuca idahoensis	--	--	+/6
Koeleria pyramidata	--	--	+/2
Poa canbyi	--	--	*
Stipa comata	1/4	--	--
Stipa spartea	--	--	+/4
Stipa viridula	--	--	*
Forbs			
Achillea millefolium	--	+/2	--
Allium textile	+/2	--	--
Antennaria plantaginifolia	--	--	+/2
Artemisia ludoviciana	--	+/2	+/4
Aster ericoides	--	+/2	+/6
Astragalus adsurgens	--	+/2	+/2
Balsamorhiza sagittata	--	--	+/2
Calochortus nuttallii	--	--	*
Cerastium arvense	--	1/12	--
Chrysopsis villosa	+/2	--	--
Cirsium undulatum	--	--	+/2
Collomia linearis	--	+/4	+/4
Helianthus rigidus	--	*	*
Liatrus punctata	+/6	--	--
Lupinus argenteus	--	+/2	--
Petalostemon candidum	+/2	--	--
Petalostemon purpureum	--	+/6	--
Phacelia linearis	--	3/24	--
Psoralea argophylla	--	--	*
Psoralea esculenta	--	*	*
Solidago graminifolia	--	--	+/2
Solidago speciosa	--	+/2	*
Sphaeralcea coccinea	+/8	--	--
Thermopsis rhombifolia	--	+/2	--
Vicia americana	--	--	2/20
Species in microplots	15	17	17
Coverage of shrubs	2	1	1
Coverage of graminoids	58	19	77
Coverage of forbs	0	4	2
Total coverage	60	24	80

Table A-22.—*Pinus ponderosa/Festuca idahoensis* and *Pinus ponderosa/Carex heliophila* habitat types.

	Pinus/Festuca		*Pinus/Carex*		
Stand number	**156**	**157**	**159**	**160**	**153**
District	A	A	S	S	A
Location					
Quarter section	SW	NE	SE	SE	SW
Section	15	31	25	26	23
Township	6S	5S	1N	1N	4S
Range	44E	44E	58E	58E	47E
Topographic position					
Slope (%)	8	10	--	3	15
Aspect (°)	215	355	--	207	150
Elevation (m)	1,250	1,237	1,213	1,225	1,244
			Coverage/Frequency		
Shrubs					
Amelanchier alnifolia	--	--	*	*	--
Artemisia frigida	--	--	--	--	*
Juniperus scopulorum	--	*	--	--	--
Rhus aromatica	--	--	*	*	+/2
Ribes cereum	--	--	*	+/2	--
Ribes missouriense	--	--	*	--	--
Rosa woodsii	--	+/10	--	--	--
Symphoricarpos albus	*	*	1/2	--	--
Graminoids					
Agropyron caninum	--	--	*	1/18	--
Agropyron dasystachyum	--	--	+/4	--	--
Agropyron smithii	*	--	--	--	--
Agropyron spicatum	4/42	1/16	3/42	+/2	+/4
Andropogon gerardi	+/6	*	--	1/4	+/4
Bouteloua curtipendula	*	1/18	--	--	--
Calamovilfa longifolia	1/4	--	--	--	--
Carex filifolia	--	--	1/6	--	--
Carex heliophila	9/46	40/96	69/99	75/99	81/99
Festuca idahoensis	33/72	49/92	--	--	2/18
Festuca ovina	--	--	*	--	--
Koeleria pyramidata	+/2	*	*	--	*
Poa canbyi	+/2	--	--	--	--
Stipa comata	--	1/8	+/2	--	*
Stipa occidentalis	--	--	--	--	+/2
Stipa spartea	--	--	--	8/42	--
Stipa viridula	*	*	--	--	--
Forbs					
Achillea millefolium	+/6	1/16	--	--	--
Anemone patens	--	--	+/2	+/2	--
Antennaria plantaginifolia	--	--	--	1/6	+/4
Antennaria rosea	+/2	1/32	*	--	--
Artemisia ludoviciana	+/2	1/14	--	*	+/2
Aster ericoides	--	+/6	--	+/2	*
Aster laevis	--	*	--	--	--
Astragalus adsurgens	+/8	--	--	--	--
Astragalus agrestis	+/2	1/14	--	--	--
Balsamorhiza sagittata	--	+/8	--	--	+/2
Campanula rotundifolia	*	+/2	--	--	*
Cerastium arvense	+/2	1/22	*	--	*
Chrysopsis villosa	*	--	--	--	--
Collomia linearis	*	+/2	--	*	+/2
Echinacea angustifolia	--	*	--	--	--
Fragaria virginiana	--	*	--	--	--
Geum triflorum	--	+/2	--	--	--
Liatris punctata	--	--	--	*	+/2
Lupinus argenteus	--	+/2	--	--	*
Oxytropis sericea	*	--	--	--	--
Psoralea argophylla	*	+/2	--	--	--
Psoralea esculenta	--	+/2	--	*	--
Solidago graminifolia	*	--	--	--	--

Stand number	Pinus/Festuca		Pinus/Carex		
	156	157	159	160	153
Solidago rigida	--	+/2	--	*	--
Thermopsis rhombifolia	--	--	--	1/8	--
Tragopogon dubius	--	+/2	--	*	--
Vicia americana	--	+/6	--	--	*
Leaf litter	70/99	61/99	58/99	59/99	67/99
Species in microplots	13	22	7	10	11
Coverage of shrubs	0	0	1	0	0
Coverage of graminoids	47	92	73	85	83
Coverage of forbs	0	5	0	2	0
Total coverage	47	97	74	87	83

Table A-23.—*Pinus ponderosa*/*Juniperus communis* habitat type.

Stand number	161	162
District	S	S
Location		
Quarter section	SE	SW
Section	26	33
Township	1N	1N
Range	58E	58E
Topographic position		
Slope (%)	25	35
Aspect (°)	347	47
Elevation (m)	1,219	1,244
	Coverage/Frequency	
Shrubs		
Amelanchier alnifolia	+/4	--
Berberis repens	1/10	*
Juniperus communis	38/56	41/54
Prunus virginiana	*	+/8
Rhus aromatica	*	+/2
Ribes cereum	+/2	+/2
Ribes missouriense	*	*
Rosa acicularis	--	*
Symphoricarpos albus	*	+/2
Toxicodendron rydbergii	--	*
Vaccinium scoparium	--	+/2
Graminoids		
Agropyron caninum	*	--
Calamovilfa longifolia	+/4	--
Carex heliophila	34/68	18/54
Danthonia spicata	1/4	1/12
Festuca idahoensis	1/2	+/2
Festuca ovina	+/2	*
Koeleria pyramidata	--	*
Stipa occidentalis	+/2	--
Stipa viridula	--	+/6
Forbs		
Achillea millefolium	--	*
Antennaria plantaginifolia	*	+/6
Cerastium arvense	*	*
Geum triflorum	--	*
Pterospora andromedea	--	*
Smilacina stellata	*	*
Solidago mollis	1/6	--
Thermopsis rhombifolia	--	1/6
Leaf litter	56/99	77/99
Species in microplots	11	12
Coverage of shrubs	39	41
Coverage of graminoids	36	19
Coverage of forbs	1	1
Total coverage	76	61

Table A-24.—*Pinus ponderosa/Prunus virginiana* habitat type.

Stand number	163	164	169	155	158
District	S	S	S	A	A
Location					
Quarter section	NE	NE	NE	NW	NW
Section	2	2	7	14	30
Township	3S	3S	18N	3S	2S
Range	61E	61E	8E	47E	47E
Topographic position					
Slope (%)	2	20	35	35	40
Aspect (°)	187	2	337	355	10
Elevation (m)	1,213	1,207	1,061	1,292	1,256
	Coverage/Frequency				
Shrubs					
Amelanchier alnifolia	2/12	6/38	8/30	11/42	5/12
Berberis repens	3/22	47/99	*	32/88	48/98
Crataegus succulenta	--	--	--	*	1/4
Fraxinus pennsylvanica	--	--	1/10	--	*
Prunus virginiana	30/96	44/88	31/92	48/84	65/94
Rhus aromatica	--	--	*	*	*
Ribes missouriense	--	+/2	3/12	2/24	1/4
Ribes odoratum	--	--	--	--	1/4
Rosa woodsii	--	+/4	7/38	8/42	2/20
Symphoricarpos albus	--	*	1/8	2/16	+/6
Symphoricarpos occidentalis	--	*	1/8	--	--
Toxicodendron rydbergii	--	2/18	1/4	22/68	7/38
Graminoids					
Agropyron caninum	--	2/6	7/48	7/46	5/36
Agrostis scabra	--	5/22	--	--	--
Bromus carinatus	--	--	--	--	*
Bromus ciliatus	--	--	--	2/14	--
Carex heliophila	65/99	36/42	+/2	--	--
Carex hoodii	--	--	--	1/4	--
Danthonia spicata	4/26	1/4	--	--	--
Elymus canadensis	--	3/16	5/26	--	--
Elymus virginicus	--	--	--	+/2	+/2
Festuca idahoensis	--	--	--	*	--
Muhlenbergia cuspidata	--	+/4	--	--	--
Oryzopsis micrantha	--	--	+/2	--	--
Poa compressa	--	--	3/14	--	--
Poa fendleriana	--	--	--	--	10/30
Poa interior	--	--	--	15/38	--
Poa pratensis	+/2	2/4	7/10	5/22	2/12
Schizachne purpurascens	+/2	1/4	10/20	3/26	--
Stipa occidentalis	16/62	1/6	--	--	--
Stipa spartea	1/4	--	--	--	--
Stipa viridula	--	+/2	--	--	--
Forbs					
Achillea millefolium	--	*	--	+/2	*
Antennaria plantaginifolia	--	--	+/2	--	--
Apocynum androsaemifolium	--	2/20	--	--	6/32
Artemisia ludoviciana	*	--	--	*	*
Aster ericoides	--	--	--	*	--
Campanula rotundifolia	--	+/4	+/2	*	1/6
Cerastium arvense	*	--	--	--	--
Disporum trachycarpum	--	--	--	7/36	1/12
Erigeron subtrinervis	--	--	--	--	*
Fragaria virginiana	--	--	--	1/14	*
Galium boreale	5/28	2/16	4/34	10/60	4/42
Geum triflorum	--	--	--	1/12	--
Heuchera richardsonii	--	--	2/14	--	+/4
Monarda fistulosa	--	--	--	*	*
Osmorhiza longistylis	--	--	--	+/2	--
Perideridia gairdneri	--	--	--	*	--
Sanicula marilandica	--	--	--	--	+/2
Smilacina racemosa	--	--	--	*	--
Smilacina stellata	+/2	2/22	1/8	1/14	*

Stand number	163	164	169	155	158
Smilax herbacea	--	--	--	+/2	--
Solidago gigantea	--	2/16	--	--	--
Solidago mollis	+/6	--	--	--	--
Taraxacum officinale	--	--	--	+/2	--
Thalictrum dasycarpum	--	2/20	--	--	--
Tragopogon dubius	*	--	--	*	--
Vicia americana	2/10	+/4	--	+/2	--
Zigadenus venenosus	+/4	--	--	--	--
Species in microplots	14	23	20	24	19
Coverage of shrubs	35	99	53	125	130
Coverage of graminoids	86	51	32	33	17
Coverage of forbs	7	10	7	20	12
Total coverage	128	160	92	178	159

Table A-25.—*Shepherdia argentea* and *Symphoricarpos occidentalis* community types.

Species	*Shepherdia argentea* (n = 11)	*Symphoricarpos occidentalis* (n = 2)
	Coverage/Frequency	
Shrubs		
Amelanchier sanguinea	4/27	--
Artemisia cana	+/9	--
Artemisia frigida	1/45	--
Cornus stolonifera	+/9	--
Crataegus succulenta	+/9	--
Fraxinus pennsylvanica	+/9	--
Juniperus horizontalis	2/18	--
Parthenocissus vitacea	2/18	--
Pinus ponderosa	+/9	--
Prunus virginiana	7/27	--
Rhus aromatica	1/45	--
Ribes americanum	2/18	--
Ribes missouriense	+/18	--
Ribes odoratum	15/55	--
Ribes setosum	--	8/50
Rosa acicularis	+/9	--
Rosa woodsii	4/100	--
Rubus idaeus	1/9	--
Shepherdia argentea	81/100	--
Symphoricarpos occidentalis	79/100	92/100
Toxicodendron rydbergii	7/82	--
Graminoids		
Agropyron caninum	7/64	--
Agropyron smithii	1/45	1/50
Andropogon gerardi	+/9	--
Andropogon scoparius	+/18	--
Bromus japonicus	19/27	1/50
Carex filifolia	+/9	--
Elymus canadensis	+/9	--
Koeleria pyramidata	+/18	--
Poa pratensis	69/100	20/100
Stipa viridula	1/27	--
Forbs		
Achillea millefolium	6/55	--
Anemone canadensis	1/27	--
Antennaria rosea	+/9	--
Artemisia ludoviciana	4/73	8/50
Chenopodium album	+/18	--
Chenopodium capitatum	1/9	--
Cirsium arvense	2/18	--
Cirsium undulatum	+/9	--
Convolvulus arvensis	1/27	1/50
Galium aparine	7/45	3/100
Galium boreale	2/18	--
Glycyrrhiza lepidota	1/36	--
Hackelia deflexa	2/18	--
Lactuca oblongifolia	+/18	--
Lupinus argenteus	+/9	--
Melilotus officinalis	+/18	--
Monarda fistulosa	5/73	--
Nepeta cataria	3/55	--
Panicum virgatum	+/9	--
Parietaria pennsylvanica	28/100	9/100
Psoralea argophylla	+/18	--
Ratibida columnifera	+/9	--
Sanicula marilandica	1/27	--
Smilacina stellata	+/18	--
Solidago rigida	+/9	--
Taraxacum officinale	2/45	--
Urtica dioica	1/36	19/50
Vicia americana	+/18	--
Viola canadensis	+/9	--

Appendix 3. Soil Analyses

Table A-26.—Selected edaphic characteristics of the upper 1 dm of mineral soil for habitat types on the Custer National Forest. All values are ranges for the stands in each habitat type.

No. of stands	pH	Mechanical analysis			Exchangeable cations (meq/100 g)			P (ppm)	C.E.C.[1] (meq/ 100 g)	O.M.[2] (%)
		% Sand	% Silt (Texture)	% Clay	Ca	Mg	K			
				***Stipa comata/Carex filifolia* habitat type**						
18	5.9–7.5	38.0–78.5	17.5–47.0	3.0–18.0	5.0–22.3	1.0–4.6	0.26–2.12	8.0–14.5	6.93–26.04	1.81–3.80
		(sandy loam, loamy sand, loam)								
				***Stipa comata/Carex heliophila* habitat type**						
10	6.0–7.5	42.0–78.4	20.0–47.0	1.6–16.0	7.5–17.1	1.1–4.1	0.32–3.66	8.4–18.0	10.22–19.21	1.84–4.19
		(sandy loam, loamy sand, loam)								
				***Festuca idahoensis/Carex heliophila* habitat type**						
8	6.1–6.7	44.5–67.0	25.0–39.5	6.0–16.0	6.9–14.6	0.8–5.1	0.41–0.78	9.9–19.7	8.70–19.49	2.43–4.14
		(sandy loam, loam)								
				***Agropyron smithii/Carex filifolia* habitat type**						
10	5.8–7.6	32.5–50.0	16.5–47.6	12.0–38.6	4.9–13.6	1.4–9.2	0.37–1.99	6.4–45.8	8.41–20.05	2.05–3.89
		(loam, clay loam)								
				***Andropogon scoparius/Carex filifolia* habitat type**						
16	6.1–7.8	34.9–78.4	16.0–48.0	5.0–21.6	8.3–20.8	1.5–8.5	0.25–4.52	6.4–11.7	12.9–25.98	1.83–5.63
		(sandy loam, loamy sand, loam)								
				***Calamovilfa longifolia/Carex heliophila* habitat type**						
4	5.9–6.4	65.0–90.5	6.9–28.4	2.6–6.6	4.0–7.5	0.9–2.2	0.36–0.54	9.9–16.3	5.40–10.19	1.13–2.60
		(sandy loam, loamy sand, sand)								
				***Agropyron spicatum/Bouteloua curtipendula* habitat type**						
3	7.7	47.0–50.4	34.0–35.2	15.6–17.8	7.9–18.3	1.1–4.1	0.33–0.42	6.6–10.9	9.33–21.32	1.86–2.65
		(loam)								
				***Agropyron spicatum/Carex filifolia* habitat type**						
2	7.5–7.7	39.2–46.9	48.5–52.0	4.8–8.8	14.8–19.0	2.1–2.2	0.62–0.71	8.2–11.7	17.71–21.72	4.03–5.03
		(silt loam)								
				***Artemisia tridentata/Agropyron spicatum* habitat type**						
5	7.0–7.7	43.0–68.0	27.5–36.0	8.0–26.0	9.1–14.3	1.6–2.9	0.34–0.71	8.0–21.0	11.74–17.28	1.52–5.30
		(loam, sandy loam, sandy clay loam)								
				***Artemisia tridentata/Agropyron smithii* habitat type**						
7	6.1–7.8	27.5–51.5	23.5–42.5	10.0–36.0	5.7–15.1	2.9–7.8	0.29–0.54	8.2–13.7	9.29–21.43	1.48–2.54
		(loam, sandy clay loam)								
				***Artemisia cana/Agropyron smithii* habitat type**						
6	7.0–7.7	31.5–46.0	32.5–46.5	16.0–26.0	6.0–19.2	1.2–6.8	0.33–1.79	7.2–12.3	7.75–26.55	2.05–2.76
		(loam)								
				***Juniperus horizontalis/Carex heliophila* habitat type**						
7	6.2–7.1	48.0–73.0	22.0–48.4	2.6–6.0	11.4–19.3	1.8–4.4	0.32–5.51	8.8–11.5	16.12–26.44	4.30–5.46
		(sandy loam)								
				***Rhus aromatica/Agropyron spicatum* habitat type**						
5	7.7–7.9	37.5–76.5	11.5–38.5	1.0–24.0	7.2–10.9	0.7–3.7	0.31–0.68	8.9–10.2	9.78–14.18	2.20–3.35
		(loam, loamy sand, sand)								
				***Rhus aromatica/Festuca idahoensis* habitat type**						
2	7.0–7.4	55.5–59.5	37.5–41.5	3.0	11.1–11.8	0.8–2.2	0.49–0.59	8.9–11.9	12.49–14.49	3.75–4.10
		(sandy loam)								
				***Rhus aromatica/Carex filifolia* habiatat type**						
4	6.9–7.6	58.0–64.0	32.0–37.4	2.6–8.0	12.8–18.1	1.9–3.9	3.20–4.92	7.4–14.5	18.12–24.78	2.43–4.79
		(sandy loam)								
				***Sarcobatus vermiculatus/Agropyron spicatum* habitat type**						
3	6.8–7.5	17.0–38.5	15.0–42.0	32.0–68.0	12.6–22.3	7.3–12.7	0.41–0.75	12.3–17.1	21.55–35.41	2.30–3.58
		(clay loam, clay)								
				***Sarcobatus vermiculatus/Agropyron smithii* habitat type**						
2	8.0–8.4	34.0–38.0	42.0–44.0	18.0–24.0	4.9–5.2	2.3–4.4	1.06–1.14	10.2–18.0	8.26–10.74	3.12–4.01
		(loam)								

No. of stands	pH	Mechanical analysis			Exchangeable cations (meq/100 g)			P (ppm)	C.E.C.[1] (meq/ 100 g)	O.M.[2] (%)
		% Sand	% Silt	% Clay (Texture)	Ca	Mg	K			
				***Juniperus scopulorum/Agropyron spicatum* habitat type**						
4	7.2–7.7	28.0–57.5	29.5–36.5	12.0–40.0 (clay loam, loam)	10.1–13.5	3.6–5.0	0.37–0.44	6.6–8.9	14.52–18.94	3.19–4.79
				***Juniperus scopulorum/Oryzopsis micrantha* habitat type**						
3	7.2–7.6	47.0–64.0	27.0–37.0	8.6–17.0 (sandy loam, loam)	9.0–14.8	4.3–7.2	0.45–0.50	6.6–9.9	13.80–18.15	1.76–4.25
				***Fraxinus pennsylvanica/Prunus virginiana* habitat type**						
17	6.3–7.5	24.0–71.9	31.0–43.4	2.6–38.0 (sandy loam, loam, clay loam, sandy clay loam)	12.1–22.5	1.2–9.0	0.66–5.68	8.0–30.4	15.14–31.11	2.18–8.12
				***Populus tremuloides/Berberis repens* habitat type**						
4	6.1–6.6	57.5–72.4	23.0–32.5	4.6–10.0 (sandy loam)	9.0–12.4	1.4–4.6	0.90–3.28	13.9–35.3	14.0–19.0	1.72–6.10
				***Pinus ponderosa/Agropyron spicatum* habitat type**						
3	6.5–7.1	58.0–87.0	10.6–34.6	2.4–7.4 (loamy sand, sandy loam, sand)	5.7–9.5	2.0–3.1	0.31–0.54	9.2–21.2	9.00–13.14	3.08–4.80
				***Pinus ponderosa/Festuca idahoensis* habitat type**						
2	5.9–6.7	50.0–73.5	20.1–37.0	6.4–13.0 (sandy loam, loam)	5.2–7.7	3.1–4.6	0.35–0.60	18.5–21.2	8.65–13.10	3.40–4.98
				***Pinus ponderosa/Carex heliophila* habitat type**						
3	5.8–6.9	56.5–78.0	16.0–32.1	5.6–11.4 (sandy loam, loamy sand)	5.0–8.7	1.4–3.7	0.50–4.03	12.1–19.7	8.88–14.13	1.96–3.48
				***Pinus ponderosa/Juniperus communis* habitat type**						
2	5.6–6.3	75.5	17.5	7.0 (sandy loam)	4.6–5.5	1.6–1.7	1.31–1.77	17.9–22.5	7.51–8.97	1.88–2.46
				***Pinus ponderosa/Prunus virginiana* habitat type**						
7	5.7–6.9	42.9–64.0	29.6–41.1	5.0–27.0 (sandy loam, loam)	2.6–20.0	2.4–5.7	0.30–3.67	13.0–21.5	6.28–26.87	2.52–7.96
				***Shepherdia argentea* community type**						
11	6.1–7.8	33.9–78.0	20.0–45.5	2.0–20.6 (sandy loam, loamy sand, sand)	8.2–18.6	2.3–5.4	0.44–1.21	7.0–12.5	13.14–24.67	2.17–6.56

[1]*Cation exchange capacity.*
[2]*Organic matter content.*

Hansen, Paul L.; Hoffman, George R. 1987. The vegetation of the Grand River/Cedar River, Sioux, and Ashland Districts of the Custer National Forest: a habitat type classification. Gen. Tech. Rep. RM–157. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 68 p.

A vegetation classification was developed, using the methods and concepts of Daubenmire, on the Ashland, Sioux, and Grand River/Cedar River Districts of the Custer National Forest. Of the 26 habitat types delimited and described, eight were steppe, nine shrub-steppe, four woodland, and five forest. Two community types also were described. A key to the habitat types and some of the changes resulting from disturbances of the vegetation also are included.

Keywords: vegetation classification, habitat types, community types

Rocky Mountains

Southwest

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